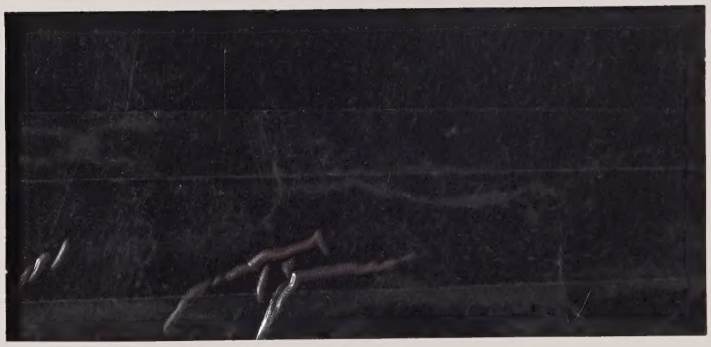
WAVETEK

OPERATOR'S MANUAL

Model 90
20 MHz Synthesized Function Generator

MP MASTER
MA34535



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OPERATOR'S MANUAL

Model 90
20 MHz Synthesized Function Generator

For Model 90 Maintenance Information, refer to separate Maintenance Manual, P/N 1006-00-0596-02.

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SAFETY FIRST

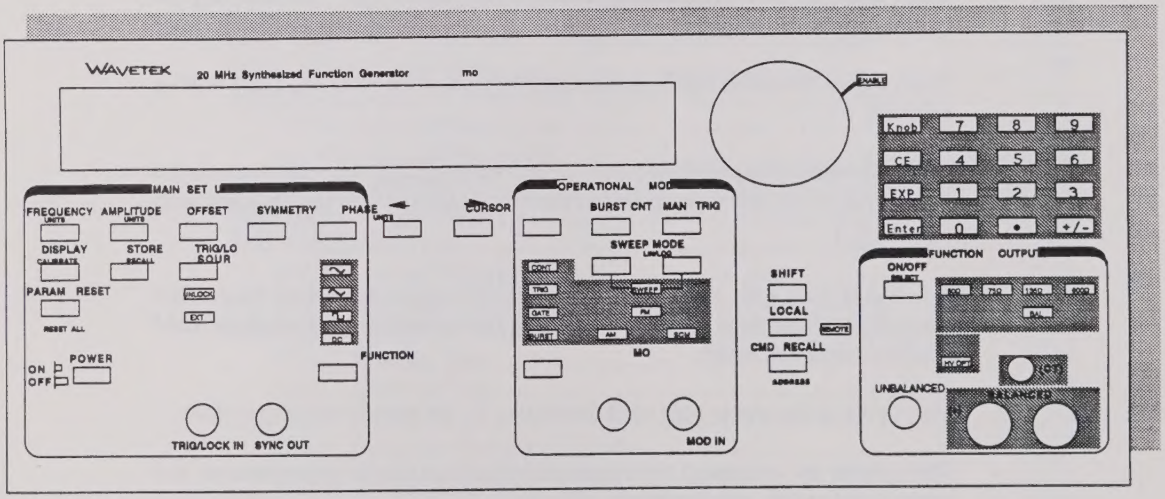
Protect yourself. Follow these precautions:

- Don't touch the outputs of the instrument or any exposed test wire carrying the output signals. This instrument can generate hazardous voltages and currents
- Don't bypass the power cord's ground lead with two-wire extension cords or plug adapters.
- Don't disconnect the green and yellow safety-earth-ground wire that connects the ground lug of the power receptacle to the chassis ground terminal (marked with ⏚ or ⚠)
- Don't hold your eyes extremely close to an RF output for a long time. The normally nonhazardous low-power RF energy generated by the instrument could possibly cause eye injury.
- Don't plug in the power cord until directed to by the installation instructions.
- Don't repair the instrument unless you are a qualified electronics technician and know how to work with hazardous voltages.
- Pay attention to the **WARNING** statements. They point out situations that can cause injury or death.
- Pay attention to the CAUTION statements. They point out situations that can cause equipment damage.

WARNING

This instrument normally contains a lithium battery. Where lithium is prohibited, such as aboard U.S. Navy ships, verify that the lithium battery has been removed.

Do not recharge, short circuit, disassemble, or apply heat to the lithium battery. Violating this rule could release potentially harmful lithium. Observe polarity when you replace the battery.



Model 90 20 MHz Synthesized Function Generator

1.1 ABOUT THIS MANUAL

The Model 90, 20 MHz Synthesized Function Generator Operator's Manual provides information on how to use the Model 90.

Section 1, General, describes and lists the Model 90 specifications.

Section 2, Preparation, describes instrument receiving and inspection, return for repair, initial checkout including fuse and voltage selection and turn on, error messages, and functional check.

Section 3,Operation, describes instrument operation – local (front panel) and remote (GPIB).

1.2 MODEL 90

The Model 90 is a rugged 1mHz to 20 MHz programmable, synthesized Function Generator. The function generator produces predefined sine, triangle, and square waveforms. Waveforms can be continuous, triggered, gated, burst, AM (amplitude modulation), SCM (suppressed carrier modulation), FM (frequency modulation) or sweep modes. Balanced or unbalanced output are programmable from 1mV to 30 Vpp with selectable output impedances. An optional high voltage output supplies outputs of up to 40 Vpp.

At frequencies above 20 Hz (all functions – Continuous, AM, and SCM modes) the Model 90 phase locks its function generator to its internal frequency synthesizer (internal phase lock) which improves the frequency accuracy to ±(10 ppm + 1.5 ppm/°C); also see Option 001. Also the Model 90 can phase lock to an external source (same conditions as internal phase lock). When locked to an external source, the phase of the Model 90's output can be varied ±180°. In addition, the internal frequency synthesizer acts as an accurate internal trigger source for the trigger, gate, or bust modes.

1.3 SPECIFICATIONS

1.3.1 Waveforms (Functions)

Programmable sine, triangle, and square; variable symmetry for pulse and ramp waveforms, and dc.

Sine Distortion

All outputs, Sine function:

<1% (-40 dB) THD 1mHz to 20 Hz;
<0.5% (-46 dB) THD 20 Hz to 100 kHz.

Unbalanced Output, 50Ω and 75Ω, no harmonics above:

-40 dBc, 100 kHz to 2MHz,
-30 dBc, 2MHz to 6MHz,
-25 dBc, 6MHz to 20 MHz.

Time Symmetry

When time symmetry is fixed at 50%, the accuracy is <±(0.2% + 5 ns). Time symmetry is variable from 5% to 95% in 1% steps to 2 MHz and the limits linearly decrease to a fixed 50% at 20 MHz. Accuracy is <±(1% + 5 ns).

Square Transition Time

The transition time (rise/fall) is <9 ns, 10% to 90%, unbalanced output into 50 Ω impedance.

Aberrations

Overshoot and ringing is <(5% + 20 mV) of the peak to peak amplitude.

Triangle Linearity

10% to 90% nonlinearity:

±1%, 2mHz to 100 kHz;
±2%, 100 kHz to 2MHz;
±10%, 2MHz to 5MHz.

1.3.2 Operational Modes

Continuous

In this mode the Model 90 supplies a continuous waveform at the selected frequency. The unit automatically selects its internal synthesizer at frequencies above 20 Hz.

Triggered

In this mode the Model 90 remains quiescent at trigger

baseline of selected function until a trigger event occurs (positive-going transition at the Trig/Freq In connector, Manual Trigger, GPIB trigger command, or internal trigger rate generator). This initiates a single waveform at the programmed frequency and, after completing the waveform, returns the generator to the quiescent baseline value ready for another triggering cycle. Internal or external phase lock is disabled in the triggered mode. The generator can also be triggered using the internal trigger synthesizer. Accuracy of triggered waveform period is <±3%.

Gated

In this mode the Model 90 functions the same as the Triggered mode, except the generator runs continuously while the triggering signal is true. The generator starts and stops in the quiescent state, and the Model 90 always complete its last cycle. Internally generated gating cycles have an approximate 1:1 on/off cycle.

Burst

In this mode, the Model 90 functions the same as the Triggered mode, except that the number of cycles generated, when triggered, is programmable from 1 to 1,000,000. The generator starts and stops in the quiescent state.

Amplitude Modulation (AM)

In this mode, the Model 90 functions the same as the continuous mode except an external signal modulates the instantaneous amplitude of the selected carrier from 0 to 100% AM. Average amplitude is as programmed except that maximum amplitude is limited to one-half its continuous value.

Suppressed Carrier Modulation (SCM)

In this mode, the Model 90 functions the same as the AM mode, except the selected function (carrier) is suppressed to zero amplitude until an external signal is applied. Three scale factors (Vout/Vin) aid in determining the input to output signal level. SCM can only be selected when the Continuous signal level is <7.5 Vpp.

Frequency Modulation (FM and VCG)

In the FM mode, an external signal controls the frequency of the generator. Connecting a dc level to the Trig/Lock In connector shifts the generator to a frequency based on the magnitude of the level. Connecting an ac signal to the Mod In deviates the frequency of the generator about its programmed frequency. The Model 90 only can be frequency modulated a maximum of three decades on a fixed range. Internal or external phase lock is not selectable in this mode.

Sweep

In this mode, the Model 90's frequency, linearly or logarithmically, sweeps between programmable start and stop frequencies of up to three decades on a selected range. The Model 90 provides five sweep modes: sweep start, sweep stop, continuous sweep, triggered sweep, or manually sweep. Sweep time can be programmed from 100 ms to 3600s. Start/Stop frequency accuracies are <±3% within the top decade, and ±5% accurate on the lower two decades of the three decade sweep range. All 50% symmetrical waveforms can be swept.

1.3.3 Frequency

Range

1mHz to 20 MHz,
20 Hz to 20 MHz, synthesized,
1mHz to 1MHz, 600Ω (Balanced, Unbalanced, and High Voltage Outputs).

Resolution

4 digits.

Accuracy

±10 ppm synthesized:
20 Hz to 20 MHz Continuous, AM, or SCM modes.

±3% of setting non-synthesized:
1mHz to 20 Hz Continuous, AM, or SCM mode;
1mHz to 20 MHz, top decade of each frequency range in triggered, gated, burst, FM, or sweep mode.

±5% of setting non-synthesized:
1mHz to 20 MHz, lower two decades of each frequency range in the FM or sweep mode.

Stability

VS temperature:
±2 ppm/°C for synthesized (0°C to 50°C);
<100 ppm/°C for non-synthesized.

VS time:
±20 ppm/year for synthesized,
±0.5% for non-synthesized within 24 hours,
±0.1% for non-synthesized within 10 minutes.

Internal Phase Lock

The Model 90 can be phase locked at frequencies >20 Hz (continuous, AM or SCM mode) to an internal crystal referenced frequency synthesizer which improves the generator's frequency accuracy and stability. A front panel annunciator (UNLOCK) indicates phase lock conditions.

External Phase Lock

The Model 90 can be phase locked at frequencies >20 Hz (continuous, AM or SCM mode) to an external phase lock signal. Model 90 measures the external signal, sets the generator's frequency, and locks the generator to the source. When external phase locked, the external source controls the generator's frequency, stability and purity.

Also, external phase lock permits programing the phase angle relative to the positive-going zero crossing of the external sine wave. Phase angle may be set from ±180° (± π radians) with 1° resolution and, in the range of 50 Hz to 10 MHz, ±(4° + 20 ns) accuracy. If the external signal has dc offset, the Model 90 ignores the offset and phase lock referenced to the "0°" point on the external sine wave.

1.3.4 Amplitude

Range

1mVpp to 15Vpp terminated into selected output impedance;
2mVpp to 30Vpp into an open circuit.

Resolution

4 Digits:
2mVpp to 20Vpp Open Circuit (1mV minimum),
1mVpp to 10 Vpp Terminated;

4 1/2 Digits:
20 Vpp to 30 Vpp Open Circuit,
10 Vpp to 15 Vpp Terminated.

Resolution may be reduced when the waveform is offset.

Accuracy

All functions at 1kHz, % of setting:
±(2% + 1mV), to 100 mVpp terminated;
±(2% + 2mV), to 1Vpp terminated;
±(2% + 10mV), to 15 Vpp terminated.

Flatness (50Ω or 75Ω)

Relative to 1kHz:

Unbalanced 50Ω

<2MHz

±0.3 dB, sine and square;
±0.5 dB, triangle.

2MHz to 20 MHz

±0.75 dB, sine and square;
±1.5 dB, triangle.

Balanced 135Ω

<100 kHz

±0.3 dB, sine.

100 kHz to 1MHz

±0.75 dB, sine.

1.3.5 Offset

Range

±7.5 V terminated;
±15 V open circuit.

Resolution

4 digits; may be reduced if both offset and waveform amplitude are programmed.

Accuracy

±(2% + 1mV), to 9.99 mV terminated;
±(2% + 2mV), to 999 mV terminated;
±(2% + 10 mV), to 7.5V terminated.

1.3.6 Outputs

Sync Output

Sync Out is a female BNC connector which supplies a TTL compatible pulse output at programmed frequency and symmetry in phase with the square function. Output level is >2Vpp to <0.4 Vpp into 50Ω termination. The 10% to 90% transition times are less than 13 ns.

Sweep Output

Sweep Out is a female BNC connector,which supplies a 0 to +5V ramp to indicate sweep position. Source impedance is 600Ω . Inactive when not in Sweep Mode.

Unbalanced Output

Unbalanced output is a female BNC connector which is the source of programmed waveform at selected frequency, amplitude, symmetry, and offset. Source impedance is 600Ω ± 1% to 1 MHz, 50Ω ± 1%, or 75Ω ± 1% to 20 MHz. Not available when the Balanced output is selected.

Balanced Output

Balanced outputs are dual "banana jack" connectors which provide differential outputs of the selected function at programmed frequency, amplitude and symmetry. A universal binding post is provided for signal common "center tap" connection. Source impedance is programmable as 135Ω ± 1% or 600Ω ± 1% to 1 MHz. Not available when the Unbalanced output is selected.

1.3.7 Inputs

Trigger/Lock Input

Trig/Lock In is a female BNC connector which serves two functions. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6

In phase lock, Trig/Lock In accepts the signal that phase locks the Model 90 to the external source. The Model 90 measures the frequency, sets the unit to match the source frequency, and phase locks the generator to the source. Model 90 phase locks range is 20 Hz to 20 MHz in the Continuous, AM or SCM modes. The input signal must be a sine wave or bipolar signal (600 mVpp to 30 Vpp).

Input impedance is 10 kΩ ± 2%.

Modulation In

Mod In, a female BNC connector, serves as the modulation input for FM (VCG), AM, and SCM. Input impedance is 10 kΩ ±2%. Bandwidth is dc to 1MHz. Maximum input level is ±20 Vpp (into 10 kΩ).

FM Mode: In FM an external signal provides linear control of waveform frequency around the programmed frequency. A ±10V input signal causes a 1000:1 frequency change (selected frequency range is the top decade in a possible three decade frequency span). An ac signal varies the frequency around the programmed frequency. A dc level sets the generator to a single frequency. VCG bandwidth is dc to 100 kHz limited by 0.06 V/μs maximum slew rate. FM bandwidth is dc to 100 kHz deviation rate; with maximum envelope distortion of 1.78% (-35 dB) taken with 10 MHz carrier frequency, 1kHz modulation frequency and 1MHz (10%) depth (sine wave modulation).

AM Mode: In the AM mode an external signal provides linear control of waveform amplitude around the programmed amplitude value. Displayed amplitude dependent scale factor specifies approximate Vpp (into 10 kΩ) required for 100% modulation. AM bandwidth is dc to 1MHz; with a maximum envelope distortion of 2% taken with 1MHz carrier frequency, 1kHz modulation frequency and 70% AM (sine wave modulation).

SCM (Suppressed Carrier Modulation): In the SCM mode, an external signal linearly controls the waveform's amplitude about the zero carrier level. The Model 90 displays a scale factor (2V/V, 0.2V/V, or 0.02V/V) which defines the amount of Mod In signal level to produce a SCM output level. SCM bandwidth is dc to 1MHz. Maximum envelope distortion is 2% (1MHz carrier and 1kHz modulation).

1.3.8 Display

The Model 90 contains a 16 digit, Vacuum Florescent Display (VFD) with 14 segment, alphanumeric characters and 11 mm character height. All selectable parameters display the parameter name, the numeric value and the unit. In addition, the display shows GPIB messages, various utilities, maintenance and diagnostic information.

1.3.8 GPIB Programming

Address

Valid GPIB addresses for the Model 90 are 0-30 (default address is 9), front panel selectable and battery backed-up.

Subsets

SH1, AH1, SR1, RL1, PP0, DC1, DT0, C0, T6, L4, TE0, LE0 and E1.

1.4 OPTIONS

001: Frequency Reference — This option improves the reference frequency from an adjustable crystal to an adjustable TCXO with a ±1 ppm performance over the operating temperature range. A rear panel REF IN connector accepts TTL or Bipolar sine wave (>500 mVpp at 10 MHz) reference input. The REF OUT connector provides TTL compatible 10 MHz pulses capable of driving a 50Ω termination.

002: High Voltage Output – This option provides a rear panel connector which supplies all functions at programmable amplitude levels from 1mVpp to 40 Vpp with a maximum output frequency of 1MHz. Source impedance is less than 5Ω, and the receiving device must have an input impedance of greater than 500Ω.

003: Handles and Rack Adapter — This option consists of a pair of handles and rack adapters that attach to the left and right sides of the Model 90. The rack adapters allow the instrument to be mounted in a standard 19 inch rack. Also included are a pair of handles which may be installed in place of the existing front panel corner pieces.

004: Extended Cards – This option supplies a set of extender cards which provide access to the daughter boards during maintenance.

1.5 GENERAL

1.5.1 Physical Specifications

Dimensions

35.6 cm (14.in.) wide, 13.3 cm (5.219 in.) high and 43.2 cm (17 in.) deep.

Weight

Approximately 7.7 kg (17 lb.) net; 11.8 kg (26 lb.) shipping.

Power

90 to 108, 108 to 126, 198 to 231, or 216 to 252 Vrms; 48 to 440 Hz; 1 phase; <110 VA.

1.5.2 Environmental Specifications

The Model 90 conforms to MIL-T-28800C, class 5.

Temperature Range

0°C to +50°C for operation;
–40°C to +70°C for storage.

Warm Up Time

Allow 20 minutes for specified operation at ambient temperature of last Auto Cal ±10°C. Auto Cal should be performed when the ambient temperature has changed.

Operational Humidity

11°C to 30°C at 95% relative humidity;
31°C to 40°C at 75% relative humidity;
41°C to 50°C at 45% relative humidity.

Altitude

To 10,000 ft. (3050m.) for operation;
To 15,000 ft. (4570m.) for non-operating.

Vibration (Operating)

Vibration level of 0.013 in. from 5 to 55 Hz (2g acceleration at 55 Hz.).

Shock (Non-operating)

40g, 9ms half-sine wave.

Bench Handling (Operating)

4 in. or point of balance drop, any face, solid wooden surface.

Electromagnetic Compatibility

The Model 90 has been tested to MIL-STD-461A Notice 4 (EL) and meets the emission and susceptibility requirements of CE02, CE04, CS02, CS06, RE02, RE02.1, and RS03.

This section contains the following elements:

Receiving and Inspecting Shipments	Paragraph 2.1
Returning Equipment For Repair	Paragraph 2.2
Preparation For Storage or Shipment	Paragraph 2.3
Preparation For Use	Paragraph 2.4
Functional Checkout	Paragraph 2.5
Routine Maintenance	Paragraph 2.6

2.1 RECEIVING AND INSPECTING SHIPMENTS

Use the following steps to inspect a shipment of Wavetek equipment.

1. **Inspect the shipment.** Before unpacking the instrument, the receiving clerk should check the shipment for missing boxes, inspect each box for damage, and if necessary, have the driver describe the box damage and list shortages on the delivery bill. If you find unreported shortages or damage, notify the shipper before further unpacking.
2. **After unpacking the boxes.** Save all of the packing material.
3. **Inspect the equipment for damage.** Inspect it carefully, regardless of the condition of the shipping boxes.
4. **If necessary, file a damage claim.** If any damage is found, call the shipper immediately (within 10 days) and start the claim process.
5. **Call Wavetek.** Call Wavetek's Customer Service department (619-279-2200) and tell them that the equipment arrived damaged.

2.2 RETURNING EQUIPMENT FOR REPAIR

Use the following steps when returning Wavetek equipment to Wavetek for repair.

1. **Save the packing material.** Always return the equipment to Wavetek in its original packing material and boxes. If you use inadequate packing material, you will have to pay to repair any shipping damage as carriers will not pay claims on incorrectly packed equipment.
2. **Call Wavetek for a Return Authorization.** Wavetek's customer service representative will ask for the name of the person returning the equipment, telephone number, company name, equipment type and serial number, and a description of the problem.

2.3 PREPARATION FOR STORAGE OR SHIPMENT

2.3.1 Packaging

If at all possible, always use the original shipping container. However, when using packing materials other than the original, use the following guidelines:

Wrap the Model 90 in plastic packing material.
Use a double-walled cardboard shipping container.
Protect all sides with shock absorbing material (minimum of 2 inch thick material) to prevent movement of the Model 90 within the container.
Seal the shipping container with approved sealing tape.
Mark "FRAGILE" on all sides, top, and bottom of the shipping container.

2.3.2 Storage

The Model 90 should be stored in a clean, dry environment. In high humidity environments, protect the Model 90 from temperature variations that could cause internal condensation. The following environmental conditions apply to both shipping and storage;

Temperature	–40°C to +70°C
Relative Humidity	Less than 95% at +25°C (sea level).
Altitude	Less 15,000 feet (4570 meters).
Vibration	Less than 2g.
Shock	Less than 40g.

2.4 PREPARATION FOR USE

Paragraph 2.4 covers the following topics

Power and Fuse Selection
Installation
Initial turn
Power ON,
Maintenance and Error codes,
Auto-Cal and Calibrate.

2.4.1 Power and Fuse Selection

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on 108 to 126 Vac line with a 1 amp fuse.

Conversion to other input voltage requires a change in rear panel fuse holder voltage card position and fuse (figure 2-1) according to the following procedure.

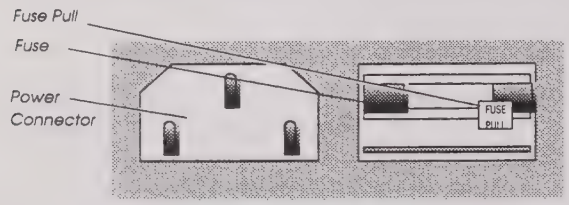


Figure 2-1 . Voltage Selector and Fuse

1. Disconnect the power cord at the instrument, open the fuse holder cover door and rotate the fuse-pull to the left to remove the fuse.
2. Read the voltage on the voltage selection printed circuit card inside the power/fuse case. Leave the card installed if the number matches the voltage needed (see the table below). To change to a different voltage, pull the card and reinsert it as shown in figure 2-1.

Card Position	Input Vac	Fuse
100	90 to 105	1A, 250Vac, Slo Blo
120	108 to 126	1A, 250Vac, Slo Blo
220	198 to 231	1/2A, 250Vac, Slo Blo
240	216 to 252	1/2A, 250Vac, Slo Blo

3. Compare the ampere rating on the fuse to the ampere ratings given in the previous table for the range of input voltages. If the fuse has the right rating, keep it. If the fuse has the wrong rating, replace it.
4. Rotate the fuse pull lever back into the normal position, insert the correct fuse, and close the cover door.
5. Connect the ac line cord to the mating connector at the rear of the unit and power source.

2.4.2 Installation

The Model 90 is primarily for bench use. For operating convenience, the Model 90 has a bail that can be adjusted to elevated the instrument.

Also, the Model 90 can be rack mounted using the two mounting ears which are available as accessories. To install the mounting ears, remove the two handle screws (each side) install the ears along with the handles using the longer screws supplied with the ears.

2.4.3 Initial Turn On

WARNING

The Model 90 Signal Generator is equipped with a three-wire power cable. When connected to a grounded AC power receptacle, this cable grounds the instrument front panel and cabinet. Do not use extension cords or AC adapters without a ground.

WARNING

This instrument uses internal batteries that contain more than 0.2 grams of Lithium. Do not charge or short this battery. A hazard of explosion and or contamination exists.

Table 2-1. Maintenance Messages and Error Codes.

Display	Probable Cause	Corrective Action
Err xxxxxxxxx	Improper self-check/unit	Press POWER key OFF and then ON.If identical failureerror is displayed, refer to section 6 (Maintenance) of the Model 90 Maintenance manual. If a different error is displayed, press the Calibrate key again. If "WAVETEK Model 90" is displayed, the unit is operational.
Low batt x.xxx v	Internal battery voltage low.	Unit is available for immediate operation. Refer to section 6 for-battery replacement.
Cal Required	Internal battery dead.	Unit has lost its calibration data but can be used after performing and passing AutoCal. Instrument may not meet all specifications.

NOTE

The bold numbers throughout the following paragraphs refer to those items described in table 3-1 and illustrated in figure 3-1.

1. Verify that only the power cable is connected to the Model 90. All other cables should be disconnected.

2. Set the Power On/Off switch (**1**) from Off to On.

When power is first applied, the Model 90 performs a Self-test which checks the internal battery, Motherboard memory and storage memory. If there are Self-test errors they will be displayed; see table 2-1. If the unit passes Self-test, it will display "WAVETEK MODEL 90".

3. Press the SHIFT key and then the RESET ALL key (**2**). Verify the following front panel conditions exist by pressing the key and viewing the display or annunciator:

Frequency	1kHz (1ms)
Amplitude	5Vpp (2.5 Vp, 1.77 Vrms, or 18 dBm)
Offset	0V
Symmetry	50%
Display	16
Store	Last stored setting
Recall	Last stored setting
Phase	0° (0 radians)
Trigger/Lock Source	Internal Lock
Trigger Frequency	100 Hz
Ext Trig	TTL
Burst Count	5
Function	Sine (Indicator Lit)
Mode	Continuous (Indicator Lit)
Sweep Mode	
Start	1kHz
Stop	10 kHz
Time	1s (1Hz) Sweep time
Linear/Logarithmic	Linear Sweep
Trigger Frequency	100 Hz (10 ms)
Function Output	
On/Off	Output Off (Impedance indicator flashes)
Select (output)	50Ω, Unbalanced
Knob	Disabled (ENABLE indicator off).

Items in parenthesis are alternate units and can be selected using the SHIFT and UNITS keys.

4. If all above conditions are correct, the signal generator is ready for operation. If a condition is incorrect, notify your maintenance department or return the instrument to Wavetek for repair.

2.4.4 Auto-Cal and Calibrate

The Model 90 provides two levels of calibration: Auto Cal and Calibrate.

Auto Cal (automatic calibration) provides a quick method of calibrating the Model 90 without using external test equipment. Auto Cal automatically sets up the instrument and takes internal measurements using internal standards. The Model 90 calculates correction values based on the measurements and stores those values in memory. These correction values are recalled from memory when the unit is powered up. Use Auto Cal when Model 90 accuracy is critical, long term instrument storage, following drastic changes in the environment, or when the operator believes Auto Cal is necessary.

After the Model 90 has warmed up for at least 20 minutes, perform the following steps:

1. Press the CALIBRATE key (SHIFT and CALIBRATE). The display shows "CALIBRATING". If the CALIBRATE key is pressed before the 20 minute warm up time has elapsed, the display shows the time until the Auto Cal starts.

2. At the end of the Auto Cal cycle the display will show "AUTOCALIBRATED" if the cycle if successful. If there are errors the display will show them. See section 6 for a listing of those errors.

Calibrate provides a more extensive method of calibrating the Model 90 using external test equipment. Calibrate does require opening the instrument and making adjustments. Use Calibrate when the Model 90 displays "CAL REQUIRED" or "ERR XXXXXXXX", when the Model 90 has been repaired or when routine calibration is scheduled. Typically, the Model 90 calibration cycle is about 1 year; section 5 describes the Calibration procedure.

2.4.5 Maintenance Messages and Error Codes

Some internal circuit failures cause maintenance messages or error codes to appear in the display. See table 2-1 for a list of possible maintenance messages/error codes and probable cause.

2.4.6 Trigger Source Selection

The Model 90 allows the selection of either a TTL or bipolar external trigger source.

To select the trigger source,

1. Disconnect the power from the Model 90.

2. Turn the Model 90 bottom side up.

3. Remove bottom cover by removing the three screws. Slide the cover back.

4. Change the jumper as shown in figure 2-2.

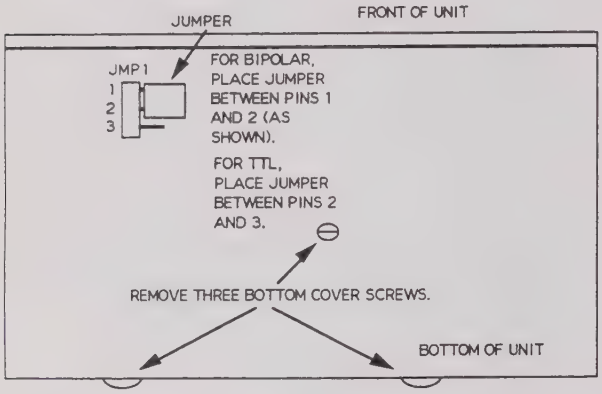


Figure 2-2. Trigger Source Selection

5. Replace the bottom cover, and secure it using the three screws.

Note

Changing the trigger selection jumper does not affect the unit's calibration.

2.5 Functional Checkout

The functional checkout provides a quick method of verifying the operation of the Model 90. The only test equipment required to perform this checkout will be a signal (modulation and trigger) source (Wavetek Model 20 or equivalent), an oscilloscope (Tektronix 2445 - dual channel or equivalent), and the appropriate cables and loads. The bold numbers in the checkout refer to items in figure 3-1 and table 3-1; for more information on the operation of the keys and connectors refer to section 3.

Connect the Model 90 to the oscilloscope and signal source; see figure 2-2.

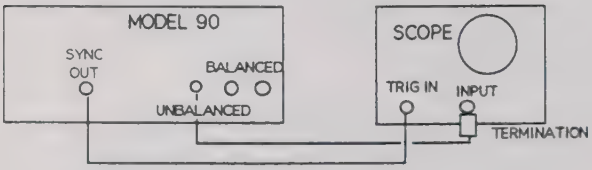


Figure 2-2. Function Checkout Interconnection

FUNCTION CHECK

1. After connecting the power cable, press the POWER switch (**1**) to turn the Model 90 on. After Self test the display shows " WAVETEK MODEL 90". The output will be off. Terminate the UNBALANCED output (**31**) with a 50Ω termination.

2 Press SHIFT key (**27**) and RESET ALL key (**2**).

Press the ON/OFF (**32**) to turn on the output.

Scope displays 1kHz, 5Vpp sine wave.

3. Press the FUNCTION key (**14**) to step through the triangle and square waveforms, and dc as shown on the scope. Press function to return to the sine function.

FREQUENCY CHECK

4. Press the FREQUENCY key (4). Press the Knob key (**35**) - ENABLE indicator (**36**) lit.

5. Rotate the knob (**37**) CW the frequency increases.

Rotate the knob CCW the frequency decreases.

6. Using the keypad (**35**) press **5 EXP 4** and ENTER to change the frequency to 50 kHz.

AMPLITUDE CHECK

7. Press the AMPLITUDE key (**5**). Press the KNOB key (**35**) - ENABLE indicator (**36**) lit.

8 Rotate the knob (**37**) CW; the amplitude increases.

Rotate the knob CCW; the amplitude decreases.

9. Using the keypad (**35**) press **5** and ENTER to change the amplitude back to 5Vpp.

MODE CHECK

10. Trigger Press the MODE key (18) until the TRIG indicator (19) lights.

The internal trigger source is the default - trigger frequency is 100 Hz.

Scope displays a 50 kHz sine wave triggered at a 100 Hz rate.

11. Connect the signal source to the TRIG/LOCK IN (**16**) connector of the Model 90 as shown in figure 2-3. Sync the scope from the signal source

Set the signal source to 100 Hz, 1Vpp square wave.

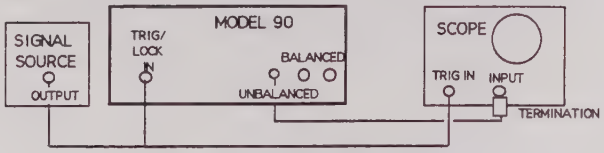


Figure 2-3. Second Setup

12. **Gate** Press TRIG/LOCK SOURCE key (**8**). If necessary, use the knob or TRIG/LOCK SOURCE key to select External Trig Source (EXTTRIG).

    Press the MODE key (**18**) and select the GATE mode - GATE indicator (**19**) lights.

    Scope displays a gated output as long as the trigger is true.

13. **Burst** Press the MODE key (**18**) and select the BURST mode - BURST indicator (**19**) lights.

    Press BURST CNT key (**20**) , press the KNOB key (**35**) - ENABLE indicator (**36**) lit, and use the knob to change the count from 5 to 2.

    Scope displays a burst of 2 sine waves.

14. **Amplitude Modulation** Press the MODE key (**18**) and select the AM mode - AM indicator (**19**) lights. Press the TRIG/LOCK SOURCE key and select INTLOCK. Connect the signal source to the MOD IN connector (**26**). See Figure 2-4. Set the signal source to 100 Hz, 1Vpp sine wave; trigger the scope from the signal source.

    Scope displays an AM signal.

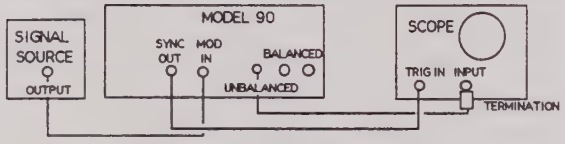


Figure 2-4. Third Setup

15. **Suppressed Carrier Modulation** Press the MODE key (**18**) and select the SCM mode - SCM indicator (**19**) lights.

    Scope displays a SCM (double side-band) signal.

16. **Frequency Modulation** Press the MODE key (**18**) and select the FM mode - FM indicator (**19**) lights.

    Scope displays a FM signal.

17. **Sweep Mode** Disconnect the signal source.

    Press the MODE key (**18**) and select the Sweep mode - Sweep indicator (**19**) lights.

    Press the SWEEP MODE key (**22**) and display the sweep start frequency.

    Use the keypad to enter 200 Hz. Press 2, EXP, 2, and ENTER.

    Press the SWEEP MODE key (**22**) and display the sweep stop frequency.

    Press the SWEEP MODE key (**22**) and CONTINUOUS SWEEP is displayed.

    Connect the Model 90's SWEEP OUT (**25**) to the scope's trigger input. Select external trigger on the scope.

    Scope displays 200 Hz to 10 kHz sweep at a 1 second rate.

PHASE SHIFT

18. Press the MODE key (**18**) and select the continuous mode - CONT indicator (**19**) lights.

    Press the TRIG/LOCK SOURCE key (**8**) twice and select the external source.- EXT indicator (**10**) lights and UNLOCK indicator (**9**) flashes.

    Set the signal source 2kHz, 2Vpp sine wave.

    Connect the signal source output to the TRIG/ LOCK IN connector (**16**) - UNLOCK indicator (**9**) goes out. The Model 90 displays EXTLOC 2 KHZ (approximate value). Trigger the scope from the signal source.

    Press the PHASE key (**12**). Press the KNOB key (**35**) to enable the knob, and rotate the knob CW, the phase of the waveform on the scope increases. Rotate the knob CCW, the phase of the waveform on the scope decreases.

BALANCED OUTPUT

19. Press the key combination of SHIFT (**27**) key and SELECT key (**32**) until both the 600Ω and BAL indicators (33) light.

20. Press the AMPLITUDE key (**5**) and use the keypad to set the output level to 10 Vpp (press 1, 0, ENTER).

21. Connect the balanced output to the scope inputs (properly terminate the Model 90 as shown in figure 2-5).

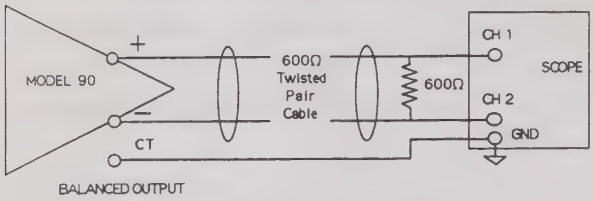


Figure 2-5. Fourth Setup

Scope Setup:

CH 1 and CH 2 - dc coupled, adjust so both waveforms have same amplitude about the horizontal centerline.

Change VERT MODE to ADD and invert CH 2.

22 View balanced output on scope.

HIGH VOLTAGE OUTPUT (OPTION 002)

23. Press the SHIFT key (**27**) and RESET ALL (**2**) to reset the Model 90 to its default parameters.

    Press the ON/OFF (**32**) to turn on the output.

    Scope displays 1kHz, 5Vpp sine wave.

24. Press the key combination of SHIFT (**27**) key and SELECT key (**32**) until the HV OPT indicator (**33**) lights.

    Connect the Model 90's High Voltage Output (**C** in figure 3-2) on the rear panel to the scope input.

    Press the AMPLITUDE key (**5**).

    Rotate the knob CW, the amplitude increases - maximum amplitude is 40 Vpp.

    Rotate the knob CCW, the amplitude decreases - minimum amplitude is 1mVpp.

2.6 ROUTINE MAINTENANCE

No tools or equipment are required for routine maintenance. Cleaning materials required are listed below:

Description	National Stock Number
Isopropyl Alcohol MIL-A-10428, Grade A (81349)	6810-00-753-4993
Lintless Cotton Cheesecloth CCC-C-440, Type II, Class 2 (81349)	8305-00-267-3015
Mild Liquid Detergent	

Routine maintenance for the Model 90 is limited to routine checks such as listed below;

Cleaning,
Dusting,
Wiping,
Checking for frayed cables,
Storing items not in use,
Covering unused receptacle,
Checking for loose nuts, bolts, and screws.

Perform these routine check anytime they need to be done.

FAN MAINTENANCE

The Model 90 contains a fan which is located on the right side of the unit. On the outside of the unit is the fan's filter . This filter should be cleaned about every month; more often if the unit is used in a dusty environment.

To clean the Filter,

1. Disconnect the Model 90 from the primary power source.
2. Using a screwdriver, gently pry off the filter's grill.
3. Remove the foam filter.
4. Clean the foam filter using a mild soapy solution. Thoroughly rinse the filter, and allow it to dry.
5. Place the filter back in the unit, and snap it in the filter grill.
6. Connect the Model 90 to the primary power source.

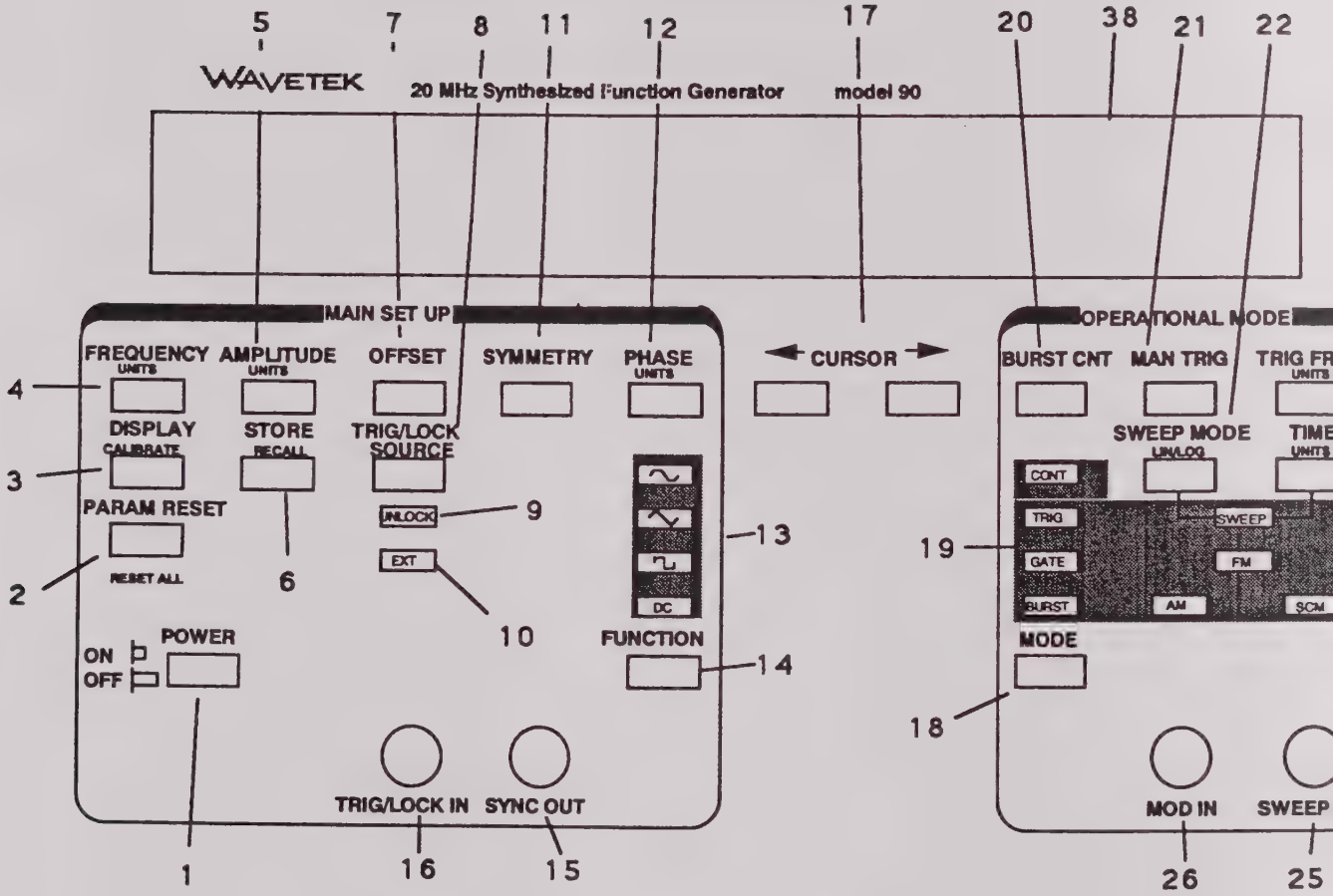
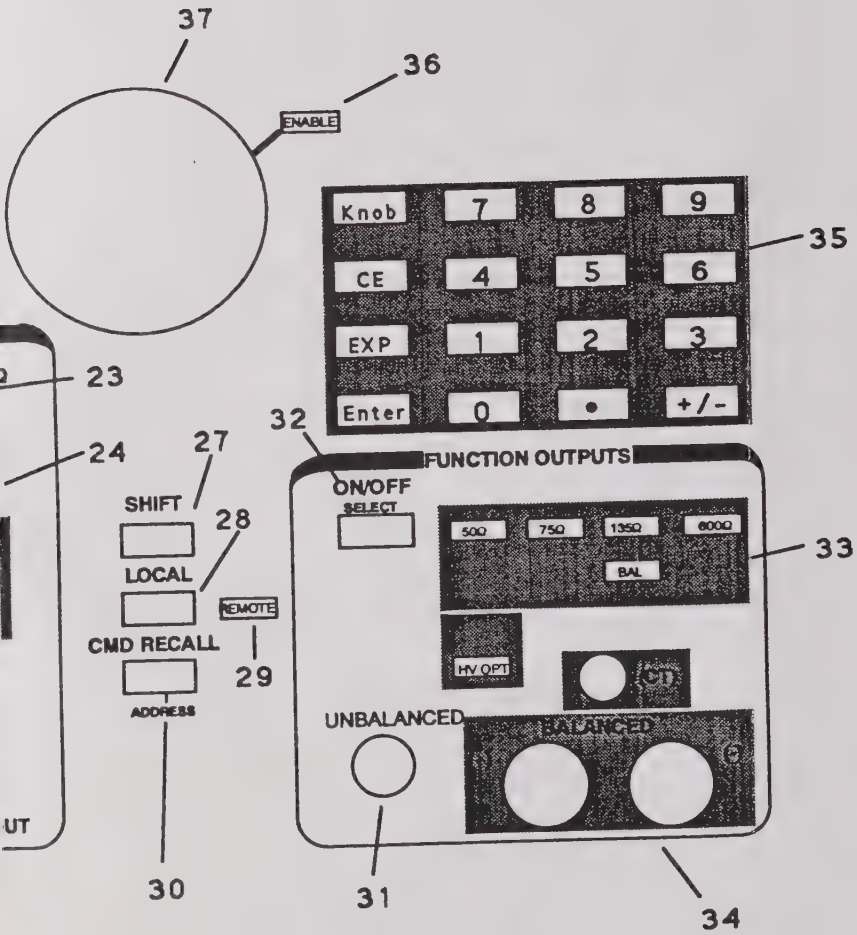


Figure 3-1. Model 90 Front Panel Controls and Connectors


37
36
ENABLE
Knob
7
8
9
CE
4
5
6
EXP
1
2
3
Enter
0
•
+/-
35
23
24
27
32
FUNCTION OUTPUTS
ON/OFF
SELECT
SHIFT
28
LOCAL
REMOTE
CMD RECALL
ADDRESS
29
50Ω
75Ω
135Ω
600Ω
BAL
33
HV OPT
UNBALANCED
BALANCED
UT
30
31
34

3.1 Introduction

This section provides operator information for the Model 90 Synthesized Function Generator and is organized as follows:

Paragraph 3.2 describes the unit's controls (keys and menus) and connectors.
Paragraphs 3.3 and 3.4 describe the Model 90 GPIB commands.
Paragraph 3.5 provides detailed instructions on how to set up the Model 90 for various tasks.

3.2 Controls Connector and Indicators

Paragraph 3.2.1 describes all the operator "Controls, Indicators, and Connectors" for the Model 90. Paragraph 3.2.2 explains the rear panel's connectors.

3.2.1 Front Panel Controls, Indicators, and Connectors

Figure 3-1 identifies the Model 90 front panel controls and connectors. The numbers in figure 3-1 are used throughout this section as well as throughout the manual to identify the keys and connectors. Table 3-1 describes the function of each control and connector of the Model 90.

Table 3-1. Front Panel Controls, Indicators, and Connectors

Key	Control, Indicator or Connector	Function
		MAIN SET UP Group
1	POWER switch	This switch turns the Model 90's power on or off. Pressing the button in turns the power on. Extending the button turns the power off. At power on, the Model 90 first performs a Self-Test which tests the motherboard memory, storage memory, checks the internal battery, and then returns the unit to its last setup (the output will be off).
2	Param Reset key	Press this key to reset the parameter currently displayed parameter to its default value; see Model 90 Default Conditions. This does not change non-displayed parameters.
	Reset All key	Press the SHIFT key and then the RESET key to reset all Model 90 parameters to their default conditions. The GPIB address remains unchanged.

Model 90 Default Conditions

Frequency	1kHz (1ms)
Amplitude	5Vpp (2.5 Vp, 1.768 Vrms, 18 dBm)
Mode	Continuous
Offset	0V
Symmetry	50%
Store	Last location stored
Recall	Last location stored
Phase	0° (0 radians)
Trigger/Lock Source	Internal Lock
External Trigger	Bipolar
Function	Sine

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
		Model 90 Default Conditions (Continued) Display 31 Burst Count 5 Symmetry 50% Sweep Mode Continuous Sweep Sweep Start 1kHz Sweep Stop 10 kHz Time 1s (1Hz) Linear/Logarithmic Linear Trigger Frequency 100 Hz (10 ms) Function Output On/Off Output Off (50Ω indicator flashes Select output 50Ω, Unbalanced Knob Disabled (Enable indicator off) The following keys are not affected by the RESET ALL key: Calibrate Address Man trigger Local
3	DISPLAY key	Press this key to adjust the intensity of the display (00 to 31) with 31 being the brightest setting. Use the knob or numeric key pad to change intensity value. The knob automatically enters the new value. When using the keypad to enter values, the ENTER key must be used to accept the new value.
	CALIBRATE key	Press the SHIFT key and then the CALIBRATE key to perform the Model 90 Autocal. Autocal performs a functional check and fine tuning of certain internal circuits. During Auto Cal the display shows "CALIBRATING", and "AUTOCALIBRATED" when finished with Auto Cal. Allow the Model 90 to warm up 20 minutes after power is
4	FREQUENCY key	Press the FREQUENCY key to display the current generator frequency . Use the control knob or numeric keypad to change the frequency value. The control knob automatically enters the new value. When using the keypad to enter values, the ENTER key must be used to accept the new value. Pressing the FREQUENCY key displays the output frequency or period (selected by the UNITS key, see UNITS). Displayed frequency units are MHz, kHz, Hz, and mHz, and displayed period units are ns, µs, ms, and s (seconds). Range is from 0.001 Hz to 20.00 MHz or 1000s to 50 ns. Default is 1.000 kHz. Specified Frequency Limits: 2MHz when symmetry is not 50%, 1MHz when 600Ω Unbalanced is selected, 1MHz when 135Ω Balanced is selected, 1MHz when 600Ω Balanced is selected.
	UNITS key	Press the SHIFT key and then the (FREQUENCY) UNITS key to change the units of measure for the FREQUENCY key. When this key sequence is performed, the current selection is displayed. Use the knob to scroll through the list (Frequency or Period); press the ENTER key to accept the desired item.
5	AMPLITUDE key	Press the AMPLITUDE key to display the current output level. Use the control knob or numeric keypad to change the output level. The control knob automatical-

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
		ly enters the new value. But when using the keypad, press the ENTER key to accept the new value. Amplitude units (see UNITS) can be Vpp, Vp, Vrms, or dBm which can be selected using the SHIFT and AMPLITUDE (UNITS) key. Output level can be 1mVpp to 15.0 Vpp, 0.5 mVp to 7.5 Vp, 0.4 mVrms to 5.3 Vrms, –56.0 dBm to +27.5 dBm. Default value is 5 Vpp. Amplitude Limits Offset values limit the amplitude. AM limits the maximum AM amplitude to one half the Continuous amplitude. SCM sets the programmed level to 0V; output level depends on magnitude of the modulating signal. Vpp and Vp are the only units of measure when dc offset is not 0Vdc and symmetry is not 50%.
	UNITS key	Press the SHIFT key and then the (AMPLITUDE) UNITS key to step between Vpp, Vp, Vrms, and dBm. When this key combination is performed, the current selection is displayed. Use the knob to scroll through the list (Vpp, Vp, Vrms, and dBm); press the ENTER key to accept the desired item.
6	STORE key	Press the STORE key to store a complete front panel instrument setup. When the key is pressed the last storage address is displayed. Use the numeric keypad or knob to select an address (1 to 10). Press ENTER to accept the setup. Use RECALL key to retrieve the stored settings.
	RECALL key	Press the SHIFT key and then the RECALL key to select a stored instrument setup. Use the knob or numeric keypad to select the storage location, then use the ENTER key to initiate that instrument setup.
7	OFFSET key	Press the OFFSET key to display the current dc offset level. Use the control knob or numeric keypad to change the dc offset value. The knob automatically enters the new value. When using the keypad, press the ENTER key to accept the new value. DC offset levels can be programmed between +7.500V to -7.500V in 1mV increments. The default value is 0Vdc. Offset values are limited to Offset + Vp ≤7.5V. In dc function, OFFSET controls the output polarity and level. In sine, triangle, and square functions, OFFSET controls the reference level of output waveform. Offset Limits Selecting the Balanced output fixes the offset at 0Vdc. Selecting AM or SCM limits the offset range to 1/2 of the maximum programmed offset. The amplitude value limits the offset value.
8	TRIG/LOCK SOURCE key	This key serves two functions based on the unit's operating mode.

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
		Continuous , AM, and SCM modes - Use this key to select either the Model 90's internal (synthesizer) phase lock source or an external phase lock source. Press this key to toggle between Internal and External sources. The minimum phase lock frequency is 20 Hz. Selecting the internal source displays the Model 90's synthesizer frequency. Selecting the external phase lock source displays the frequency of the signal at the TRIG/LOCK IN connector. At frequencies above 20-Hz the Model 90 measures the input frequency, sets its frequency to match, and locks itself to the external source. **TRIG, GATE, or BURST mode** - Use this key to select either the internal (synthesizer) trigger source or an external trigger source. Press this key to toggle between Internal and External sources. Selecting the internal trigger source displays the trigger frequency (TRIG FREQ key). The internal trigger frequency range is 1mHz to 20-MHz. Selecting the external trigger source displays the frequency of the signal at the TRIG/LOCK IN connector.
9	UNLOCK indicator;	When this indicator is off, the unit is locked to either the internal or external frequency reference. A flashing indicator means the external reference is not connected, or the internal reference has a problem. A continuously lit indicator means the current instrument setup does not allow locking to a frequency reference.
10	EXT indicator	When on, it indicates the Model 90 requires an external reference or trigger source at the TRIG/LOCK IN connector. It does not indicate signal is present at the connector.
11	SYMMETRY key	Press the SYMMETRY key to display the current waveform symmetry value. Symmetry values are expressed in percent (%). Waveform symmetry can be varied between 5% and 95% in 1% increments. Use the knob or keypad to change the waveform symmetry value. The control knob automatically enters the new value. When using the keypad, press the ENTER key to accept the new value. The default is 50%. When either BAL, FM(VCG), or Sweep is selected, the symmetry is fixed at 50%. Symmetry range decreases linearly between 2MHz and 20 MHz. At 20 MHz the symmetry is fixed at 50%.
12	PHASE key	Press PHASE key to display the current selected phase shift. Use the control knob or keypad to change the phase relative to the TRIG/LOCK IN signal. The control knob automatically enters the new value. When using the keypad, press the ENTER key to accept the new value. The phase can be varied from +180° to –180° (+3.14 to –3.14 radians) with 3 digits of resolution. Default is 0°. Use the UNITS key to shift between degrees and radians.
	UNITS key	Press the SHIFT key and then the (PHASE) UNITS key to display the current unit of measure for phase. Use the knob or SHIFT/UNITS combination to step from Degrees to Radians; press the ENTER key to accept the selection.
13	DC indicator	When on, indicates that dc function is selected. To activate, press the FUNCTION key (14) until indicator lights. The dc function cannot be selected when Balanced output, AM mode, or phase lock on is selected.
	⊓⊔ (square) indicator	When on, indicates that a square waveform is selected. To activate, press the FUNCTION key (14).
	∿ triangle) indicator	When on, indicates that triangle waveform is selected. To activate, press the FUNCTION key (14).

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
	~ (sine) indicator	When on, indicates that sine waveform is selected. To activate, press the FUNCTION key (14).
14	FUNCTION key	Press the FUNCTION key to select the output waveform. Press and hold this key to cycle the unit through its functions (sine, triangle, square, and dc). A lit indicator identifies the selected function. Release the function key to select a function. To step backwards through the functions, press the SHIFT key and then hold down the FUNCTION key. Release the FUNCTION key when the indicator lights to select the function.
15	SYNC OUT connector	The signal from this output connector may be used to synchronize external equipment to the Model 90. Output impedance is 50Ω. The output signal is a TTL pulse. The Sync signal will be the same frequency as the output waveform frequency. The symmetry is same as square wave and "in phase" with square wave but leads sine and triangle waveforms by 90°. There will not be a Sync Out signal for the dc function.
16	TRIG/LOCK IN connector	This is the input connector for the trigger or phase lock source. Input impedance is 10 kΩ. Input signal can be either a logic level or bipolar sine wave. **Phase Lock** - To phase lock, the external source must be between 20 Hz and 20 MHz, and the level must be 600 mVpp to 30 Vpp or TTL level. The Model 90 automatically sets its frequency to match the external source. In addition, the Model 90 displays the frequency of the external source. **External Trigger** - In trigger modes, it accepts trigger source. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6
	CURSOR	
17	CURSOR keys	Press these keys to select a digit. A flashing digit moves either left (< key) or right (> key) each time the CURSOR key is pressed.
	OPERATIONAL MODE Group	
18	Mode key	Press the MODE key to step through the Model 90's operating modes: Cont (continuous) Trig (triggered) Gate (gated) Burst AM (amplitude modulation) FM (frequency modulation) SCM (Suppressed Carrier Modulation) SWEEP To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.
19	CONT indicator	When on, it indicates the continuous mode is active. Use the MODE key (18) to select this operating mode.

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
	TRIG indicator	When on it indicates the triggered mode is active. The Model 90 must be triggered to initiate a trigger cycle. Use the MODE key (18) to select this operating mode.
	GATE indicator	When on, it indicates the gated mode is active. The Model 90 must be triggered to initiate a gate cycle. Use the MODE key (18) to select this operating mode.
	BURST indicator	When on, it indicates the burst mode is active. Use the BURST CNT key (20) to select the burst count. The Model 90 must be triggered to initiate a burst cycle. Use the MODE key (18) to select this operating mode.
	AM indicator	When on, it indicates that the Amplitude Modulation mode is active. An external signal source connected to MOD IN connector (26) is required for AM operation. Use the MODE key (18) to select this mode. AM can not be selected when the sum of amplitude (Vpp) and Offset (Vdc) exceeds 7.5V.
	FM Indicator	When on, it indicates that FM/VCG modulation mode is active. An external signal source connected to MOD IN connector (26) is required for FM/VCG operation. External signal amplitude of 0 to 10 Vpp controls deviation. External signal frequency of dc to 100 kHz. Use the MODE key (18) to select this operating mode. FM can not be selected when symmetry is not 50% or when external phase lock is selected.
	SCM indicator	When on, it indicates the Suppressed Carrier Modulation mode is active. An external signal source connected to MOD IN connector (26) is required for SCM operation.
	SWEEP indicator	When on, it indicates the sweep mode is active. Use the SWEEP MODE key to select the sweep start and stop frequencies, and sweep conditions. Sweep can not be selected when the symmetry is not 50% or the generator is in external phase lock..
20	BURST CNT key	Press the BURST CNT key to display the currently selected burst count. Use the knob and keypad to change the burst count. The knob automatically enters the new value. When using the keypad, press the ENTER key to accept the new value. Burst count values range from 1 to 1,000,000 cycles.
21	MAN TRIG key	Press this key to trigger the generator. In the triggered mode, the generator produces one complete cycle of the waveform each time the key is pressed. In the gated mode, the generator produces continuous waveforms as long as the key is pressed. When the key is released, the waveforms stop. In the burst mode, the generator produces the preset number of cycles.
22	SWEEP MODE key	Press the SWEEP MODE key to step through a list of sweep related items: sweep start, sweep stop, sweep run, triggered sweep, and manual sweep. The Model 90 limits the sweep range to three decades. If the sweep start frequency is set and the sweep stop frequency exceeds the three decade limit, the start frequency will be pulled up. If the sweep stop frequency is set and the sweep start frequency exceeds the three decade limit, the stop frequency will be pulled down. **Sweep Start** displays and sets the generator to the currently selected sweep start frequency. The unit displays sweep start frequency in mHz, Hz, kHz, and MHz. The sweep start frequency range is from 1mHz to 20 MHz. Default is 1kHz. Use the knob or keypad to change the sweep start frequency. The knob automatically enters the new sweep start frequency. When using the keypad, press the ENTER key to accept the new sweep start frequency. **Sweep Stop** displays and sets the generator to the currently selected sweep stop frequency. The unit displays the sweep stop frequency in mHz, Hz, kHz, and MHz. The sweep stop frequency range is from 1mHz to 20 MHz. Default sweep start frequency is 10 kHz. Use the knob or keypad to change the sweep stop fre-

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
		quency. The knob automatically enters the new sweep stop frequency. When using the keypad, press the ENTER key to accept the new sweep stop frequency. **Continuous Sweep** starts continuous sweeping between the sweep start frequency and the sweep stop frequency. The TIME key (24) sets the repetition rate of the sweep. The SWEEP mode must be selected. **Triggered Sweep** allows the Model 90, upon receipt of a trigger, to sweep between the sweep start frequency and the sweep stop frequency. The TIME key (24) sets the rate of the sweep. Sweep mode must be selected. **Manual Sweep** allows operator to manually sweep the Model 90 between the sweep start frequency and the sweep stop frequency using the knob or the keypad. The sweep mode must be selected.
	LIN/LOG key	Press the SHIFT and then the LIN/LOG key to display the current sweep type. LIN allows the unit to linearly sweep from the start to the stop frequency. LOG allows the unit to exponentially sweep between the start to the stop frequency. In addition, both sweep types allow sweep up and down (start to stop and back to start frequency). Use the knob or SHIFT and LIN/LOG key to change the sweep type.
23	TRIG FREQ key	Press the TRIG FREQ key to display the currently selected internal frequency. Use the knob and the keypad to change the trigger frequency. The knob automatically enters the new trigger frequency. When using the keypad, press the ENTER key to accept the new trigger frequency. Internal trigger frequency range is 1mHz to 20 MHz. Use the TRIG/LOCK SOURCE key (8) to select the internal trigger source. When using the Triggered Sweep Mode, the internal trigger frequency range is 0.01 to 10 Hz.
	UNITS key	Press the SHIFT and then the (TRIG FREQ) UNITS key to change the units of measure for the trigger frequency. When this key sequence is performed, the current selection is displayed. Use the knob to scroll between Frequency and Period; press ENTER key to accept the item.
24	TIME key	Press this key to display the currently selected sweep time. The sweep time range is 10 to 2.78E-4 Hz (frequency) or 0.1 to 3600 seconds (period). Default is 1 second. Use the knob or the keypad to change the sweep time. The knob automatically enters the new sweep time. When using the keypad, press the ENTER key to accept the new sweep time.
	UNITS key	Press the SHIFT key and then the (TIME) UNITS key to display the time's units of measure. Use the knob or SHIFT and UNITS key to toggle between Frequency or Period.
25	SWEEP OUT connector	This BNC connector supplies a 0 to +5V or +5 to 0V linear ramp which represents start to stop frequencies. The ramp's rate depends on the selected sweep time. Output impedance is 600Ω. Use this output as an external sweep or horizontal signal source. The sweep out signal is only present during sweep modes.
26	MOD IN connector	This connector receives the modulation signal for the Model 90's FM, AM, and SCM modes. Input impedance is 10 kΩ. **FM** - The signal modulates the frequency of the generator. A ±10V signal varies the frequency a maximum of 1000:1 frequency change on the same range. When FM is selected, the Model 90 locks on to the same range. The frequency (dc to 100 kHz) of the external signal controls the modulation rate. When MODE: FM is selected, the Model 90 displays the scale factor: XXXX Hz/Volt $_{(input)}$.

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
		AM - The signal modulates the output level of the generator; the generator provides the carrier. The unmodulated output level will be one-half the programmed level. The frequency range of the source is dc to 1MHz. When MODE: AM is selected, the Model 90 displays the scale factor: XXXX $V_{(input)}$ = F.S. (100% modulation). **SCM** - The signal modulates the output level of the generator; the generator provides the carrier. The unmodulated output level will be 0V regardless of the output level. When MODE: SCM is selected, the Model 90 displays a scale factor: X V/V (Vin/Vout). Where X represents 2V/V, 0.2V/V, or 0.02V/V which are selected using the knob. SCM output level depends on the magnitude of the modulating signal. The frequency range of the source is dc to 1MHz.
		SHIFT/LOCAL/REMOTE
27	SHIFT key	Press the SHIFT key to select alternate key items. Shift items are shown in blue on the front panel under the major item.
28	LOCAL key	Press this key to return the Model 90 to front panel control from the remote (GPIB) mode. Front panel displays "GOTO LOCAL". Press to activate. This key will not select if Local Lockout set by external Controller during remote operation.
29	REMOTE indicator	When on, indicates that Model 90 is in remote (GPIB) operation using the external Controller. When on, instrument settings can be queried but not changed.
30	CMD RECALL key	Press this key (command recall) to display the last 40 parameters, values and action (all in ASCII code) sent to the instrument via the keyboard and the GPIB. The display shows only 16 characters at a time, use the CURSOR keys to step through the entire program string.
	ADDRESS key	Press the SHIFT key and then the ADDRESS key to display the current GPIB address. The address is displayed as a decimal value. Use the knob or keypad to change the address. The knob automatically enters the new GPIB address. When using the keypad, press the ENTER key to accept the new GPIB address. Addresses range from 00 to 30. Default address is 09. This key is inactive when Local Lockout is set by an external Controller during remote operation.
		FUNCTION OUTPUTS Group
31	UNBALANCED output	This BNC connector supplies the unbalanced (single ended) output of all the Model 90's functions. Output impedance can be 50Ω, 75Ω, or 600Ω. Frequency range is 1 mHz to 20 MHz (50Ω and 75Ω) and 1 mHz to 1 MHz (600Ω). Use the SELECT key (32) to select unbalanced output; the BAL indicator will be off.
32	ON/OFF key	Press this key to toggle on and off the balanced and unbalanced outputs. At power up the output will be turned off, but the last selected output impedance indicator will flash. Once the key is pressed, the output turns on and the impedance indicator remains lit.
	SELECT key	Press the SHIFT key and then the SELECT key to select the output connector and output impedance. Hold the key down to increment through the selections. Release the key to activate the output. Output impedance depends on the selected output: Unbalanced - 600Ω, 50Ω, and 75Ω, Balanced - 135Ω and 600Ω. HV OPT - Option 002 installed. Default is 50Ω UNBAL.

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
33	50Ω indicator	When on, it indicates 50Ω unbalanced output is selected. Use the SELECT key (32) to select 50Ω.
	75Ω indicator	When on, it indicates 75Ω unbalanced output is selected. Use the SELECT key (32) to select 75Ω.
	135Ω indicator	When on, it indicates 135Ω balanced output is selected. Use the SELECT key (32) to select 135Ω.
	600Ω indicator	When on, it indicates 600Ω unbalanced or balanced output is selected. Use the SELECT key (32) to select 600Ω.
	BAL indicator	When on, it indicates the Balanced output connectors are the selected generator outputs. When off, it indicates the Unbalanced output connector is the selected generator output. Use the SELECT key (32) to select balanced output.
	HV OPT indicator	When on, it indicates the rear panel HV OUT (C - figure 3-2) connector is the selected generator output. Use the SELECT key (32) to select the unbalanced output.
34	BALANCED output	The balanced (differential) output consists of two jacks BALANCED (+) and (-) and one center tap (CT) terminal. The BALANCED (+) jack provides the positive (in phase) balanced output. The BALANCED (-) provides the negative (180° phase) balanced output. Output impedance between the (+) and (-) terminals can be 135Ω or 600Ω. Use the SELECT key (32) to select the BALANCED output; BAL indicator is lit.
	KEYPAD	
35	Keypad	Press these keys to enter a 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9 for numeric data entry. Used them with +/–, Decimal, ENTER, EXP (exponent), and CE (clear entry) keys to enter data. Parameters that have not been entered using the ENTER key are preceded with *.
	+/- key	Press this key to enter a positive or negative sign for numeric data entry. Used for standard and exponent entry. Blank indicates positive, – indicates negative. Press to change sign.
	. (Decimal) key	Press this key to enter a decimal point for numeric data entry.
	ENTER key	Press this key to accept entries from the keypad. Also, use the ENTER key to accept items from a knob controlled scroll list. Pressing after numeric data entry transfers the display contents to Model 90 internal circuits. All values entered not within specifications are disregarded. Values exceeding resolution are rounded or entered to nearest allowable value. Parameters that have not been entered using the ENTER key are preceded with *.
	EXP key	Press this key to enter an exponent digit. To enter an exponent, use keypad to enter prefix, press EXP key, then exponent value using Numeric key 0 to 9. Exponent can be entered as a negative by pressing +/– key.
	CE key	Press this key to clear a numeric entry error when using the Numeric keys. Unwanted data must be cleared before pressing Enter key. Press once to clear display of numeric entry.
	KNOB/DISPLAY	
36	KNOB key	Press this key to enable or disable the knob. Default is knob is off.
	ENABLE indicator	When on, it indicates that Knob will change the value in the display. Press the Knob key (35) to activate. ENABLE indicator lights only when the parameter can be changed using the Knob (37).

Table 3-1. Front Panel Controls, Indicators, and Connectors (Continued)

Key	Control, Indicator or Connector	Function
38	Display	The display (a 16-digit alphanumeric display with decimal point and minus sign) shows output signal information, entry information, operator messages, and error codes.
37	Knob	Rotate the knob to change numeric value of flashing digit as selected by knob key (**35**). CW rotation increases value, CCW rotation decreases value. Active when ENABLE indicator is on.

3.2.2 Rear Panel Connectors

This paragraph provides information on the location (as shown in figure 3-2), description, and use of the rear panel connectors.

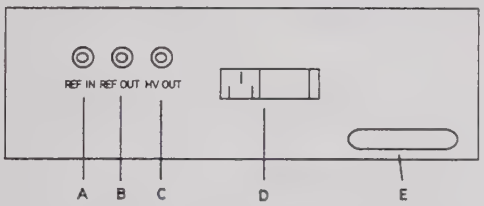


Figure 3-2. Rear Panel Connectors (Rear View)

Table 3-2. Rear Panel Controls and Connectors

Key	Control or Connector	Function
A	REF IN connector	This connector accepts an external reference input. The external source must be 10 MHz ±500 kHz at a TTL level. Option 001 must be installed.
B	REF OUT connector	This connector supplies a 10 MHz TTL reference signal. Option 001 must be installed.
C	HV OUT connector	This connector supplies the high voltage output (up to 40 Vpp) when selected by the SELECT key (**32**). Source impedance is 5Ω and is capable of driving 40 Vpp across 500Ω. Option 002 must be installed.
D	Input Power connector	This is the primary ac power input connector for the Model 90. Included in the connector is the line fuse and voltage selector. The input power connector accepts female end of power cable (supplied). A protective grounding conductor connects the Model 90 through this connector. Use the voltage selection card to setup the input voltage. **Voltage Range** — **Fuse** 90 to 108 Vrms — 1A/250V 108 to 126 Vrms — 1A/250V 198 to 231 Vrms — 0.5A/250V 216 to 252 Vrms — 0.5A/250V
E	GPIB connector;	Use this connector to mate the Model 90 to an external GPIB controller for remote operation. The connector has 24 pins and threaded posts conforming to IEEE-488-1978. Figure 3-3 illustrates the GPIB connector pinouts.

3.3 INITIAL GPIB (Remote) SETUP

This paragraph describes the initial Model 90 to controller setup for remote (GPIB) operation. The Model 90 digital interface conforms to IEEE 488.1 subsets SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT0, C0, and E1.

In remote, an external controller transmits commands to the Model 90 and receives commands from the Model 90.

Remote operation is similar to local operation (paragraph 3.2) except commands set up the Model 90. GPIB permits remote control of all functions except POWER switch, LOCAL key, and ADDRESS key. Refer to paragraph 3.2 for descriptions of controls, indicators, and connectors. GPIB connector wiring data is shown in figure 3-3.

Model 90 to Controller Setup

Perform the following steps to setup the Model 90 for remote operation. The numbers listed with the keys in the following steps are defined in table 3-1 and illustrated in figure 3-1. The letters listed refer to figure 3-2 and table 3-2.

1. Connect a GPIB interconnect cable between the Model 90 and the controller as shown in figure 3-4. The Model 90 GPIB connector (E) is located on the rear panel of the instrument.

   NOTE

   Keep GPIB interconnect cable length below 2 meters (6.6 feet)

2. Set the Model 90 GPIB address to match the address used by the controller.

   To set the GPIB address, press the SHIFT key (27) and then the ADDRESS key (30) to display (38) the current GPIB address. The address is displayed as a decimal value. Use the knob (37) or keypad (35) to change the address. The knob automatically enters the new GPIB address. When using the keypad press the ENTER key (35) to accept the new GPIB address. Addresses range from 00 to 30. Default address is 09. When the controller sets local lockout, the Address key is inactive. See figure 3-5.

3. Use the controller and GPIB commands (table 3-4) to send a command string to the Model 90.

LOCAL Key

The LOCAL key (28) switches control of the Model 90 from the GPIB bus to the front panel. Receipt of any GPIB command (if the controller simultaneously asserts the REN line of the GPIB) by the Model 90 disables the front panel to the extent that parameter settings can be read but modes or numbers cannot be changed. Pressing the LOCAL key returns full control to the front panel except when the universal command LLO has been issued by the controller. LLO disables the LOCAL key so full control cannot be obtained at the front panel.

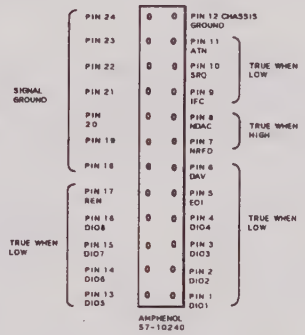


Figure 3-3. GPIB Wiring Connector Pinout

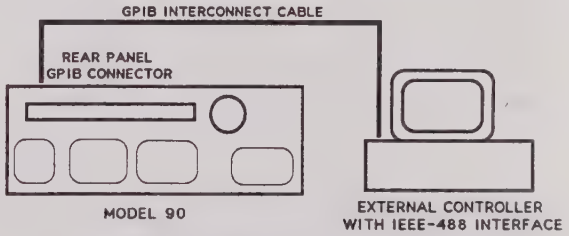


Figure 3-4. GPIB Interconnect Wiring

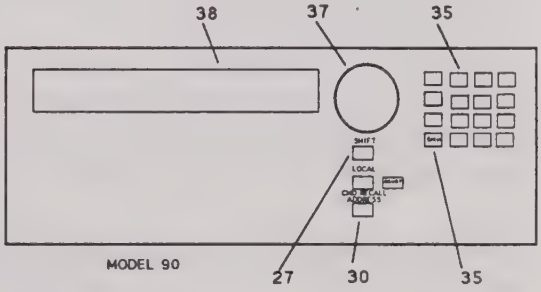


Figure 3-5. GPIB Operation Control Setup

3.4 GPIB COMMAND STRUCTURE

3.4.1 Introduction

Paragraph 3.4 covers the following topics:

Model 90 Commands	Paragraph 3.4.2
Universal and Addressed Commands	Paragraph 3.4.3
Detailed Command Descriptions	Paragraph 3.4.4
Service Requests	Paragraph 3.4.5
Displaying Messages	Paragraph 3.4.6
Selftest Query Responses	Paragraph 3.4.7

3.4.2 Model 90 Commands

Paragraph 3.4.2 discusses the Model 90 commands and the rules that must be followed to apply them.

Commands Types	Paragraph 3.4.2.1
Command Syntax	Paragraph 3.4.2.2
Command List	Paragraph 3.4.2.3

3.4.2.1 Command Types

The Model 90 has four types of commands: parameter, enumerated, direct, and query. The following text discusses each type. A column in table 3-4 provides a link between the Model 90 GPIB commands and this paragraph. The examples terminate the commands with semicolons (;) or closing quotes (“). The controller may send just the command name without a value and the Model 90 will display that parameter's current value. Replacing the numerical value with a “?” (query) will make the Model 90 display and send the current value to the controller as a string of characters. Do not send an EXECUTE command after a query command, the string will not be sent because the EXECUTE command has put the Model 90 in a “listen for more commands” mode. See “terminators” for more information.

Parameter Commands

Parameter commands specify a particular numerical value within a continuous range of values. The values should use exponential (E) notation.

Format: <header>SPACE<value>TERMINATION

The header specifies the parameter and the value specifies the numerical value. Table 3-4 lists the parameter commands and their allowable value ranges.

Examples

FREQUENCY 2E3;	Sets the frequency at 2kHz.
PHASE 87;	Sets the phase at 87°.
SWEEPTIME 2.3;	Sets the sweep time at 2.3 seconds.

Enumerated Commands

Enumerated commands provide a list of distinct choices. Either the name or numerical value can be used.

Format:
<header>SPACE<argument>TERMINATION

The header specifies the parameter and the argument specifies the choice. A number or a descriptive character string can be used for the argument. Table 3-4 lists the enumerated commands and their arguments.

Example

FU 2 or FU SQ	Selects square wave.

Direct Commands

Direct commands make the Model 90 perform an immediate action.

Format: <header>TERMINATION

The header specifies the action. Direct commands have no value or argument. Table 3-4 lists all the direct commands.

Examples

RESET;	Resets 90 parameters
TRIGGER;	Triggers waveform or sweep
EXECUTE;	Executes preceding commands in string.
FASTEXECUTE;	Executes the command string without error checking.

Query Commands

Query commands tell the Model 90 to send information to the controller. However, the Model 90 will not send the information when it receives the command, but waits until the controller addresses it as a talker. Only one query command can be sent at a time. If two or more are sent in a query string, the Model 90 responds to the last query.

Format: <header> <?>TERMINATION

The header specifies the type of information. Because all parameter command headers (and most enumerated command headers) can also serve as query headers, the question mark tells the Model 90 to send (rather than receive) the information. Certain other headers appear only in query commands. See Query Commands in paragraph 3.4.2.2, Model 90 Command Syntax for a sample query program.

Parameter Header Examples:

FREQUENCY?;	Returns current frequency.
PHASE?;	Returns current phase.

Enumerated Header Examples:

FUNCTION?;	Returns current output waveform.
OUTPUT?;	Returns current output setting.

Query Header Examples:

MAINPARAMETERS?;	Returns current main parameters.
SRQ?;	Returns current SRQ byte.
STATUSBYTE?;	Returns status byte.

3.4.2.2 Model 90 Command Syntax

Commands sent by an instrument controller to the Model 90 must follow the syntax given in table 3-3. The following text discusses command string operation, command processing, terminators, minimum uniqueness, and query commands.

Command String Operation

The command string works as follows:

WRITE @ 709:"FR 2E4;OS 1;FU SQ;FR;EX"

WRITE @ 709:"	This command depends on the controller used.
FR 2E4	Sets the frequency to 20 kHz.
OS 1	Selects Unbal 75Ω output .
FU SQ	Selects a square waveform.
FR	Tells the Model 90 to display the frequency value.
EX	Makes the Model 90 convert all these commands to a signal output.

How Does the Model 90 Process Commands?

The Model 90 256-character listen buffer receives the commands from the instrument controller. If the listen buffer fills up before receiving an EXECUTE command, it will stop accepting commands, distribute its contents to the next-setup registers, then again accept commands. The commands in the next-setup registers will not take effect until the Model 90 receives an Execute.

The listen buffer accepts all commands regardless of syntax errors. When the Model 90 processes the commands in the listen buffer, it copies the defective commands over into the SRQ buffer and labels them with PE:0 to indicate defective syntax. The parameters and functions that the defective commands would have changed remain unchanged. If a command appears in the SRQ buffer, the Model 90 ignores it.

Terminators

A terminator tells the Model 90 that it has reached the end of the current command. The Model 90 recognizes spaces, semicolons (;), and the Execute command as terminators.

When the Space is used, the Model 90 accepts only those good commands up to the defective commands and places all commands (good and bad) after the first defective command in the SRQ buffer.

When Semicolons are used, the Model 90 accepts all commands and places only the defective commands in the SRQ buffer.

Consider these two examples with and without semicolons:

With Semicolons

Write @ 709:"FR2E4;OP 1;FU SQ;FR;EX"

Message: SRQ = /PE:0 FR2E4*/

Without Semicolons

Write @ 709:"FR2E4 OP 1 FU SQ FR;EX"

Message: SRQ = /PE:0 FR2E4* OP 1 FU SQ FR EX/

Minimum Uniqueness

The Model 90 will interpret the following three command lines exactly the same. String 1 uses the minimum character set each command requires, string 2 uses longer abbreviations that contain each command's minimum character set, while string 3 completely spells out each command. The expansion of the function command (FU DC, FUNC DC, and FUNCTION DC) demonstrates the use of numbers and descriptive character strings in the argument of enumerated commands. Table 3-4 lists all minimum unique characters for all commands.

String 1:

Write @ 709:"FR 2E4;OP 1;FU 3;FR;EX"

String 2:

Write @ 709:"FREQ 2E4;OP 1;FUNC SQR;FREQ ;EXEC"

String 3:

Write @ 709:"FREQUENCY 2E4;OUTPUT

Table 3-2A. Sample Command Set

COMMAND	MIN UNIN.	COMMAND TYPE (3.4.2.1)	RANGE VALUE Min.	Max.	DESCRIPTION	ASSOCIATED
FREQUENCY	FR	Parameter	1E-3	20E6	Selects Frequency Hz.	FREQUENCY (4)
FREQUENCY?	FR?	Query			Requests current frequency.	FREQUENCY (4)
FUNCTION	FU	Parameter	0	7	Selects Function.	FUNCTION (15)

1;FUNCTION SQUARE ;FREQUENCY;EXECUTE"

Query Commands

Query commands (such as FR?) make the Model 90 return the current setting of the parameter as a string of characters and require a program to make the controller use the returned data. The following controller program example requests the data, accepts it, and writes the data to its screen.

Program Statements	*Explanation*
10 CLEAR	Clear screen
20 WRITE @ 709:"FR?"	Write command to Model 90 (port 7, address 09)
30 DIM STRING$*25	Dimension string to 25 characters
40 READ @709:STRING$	Read returning string
50 PRINT STRING$	Print string to screen
60 END	End program

3.4.2.3 Model 90 Command List

Table 3-4 contains a listing of all Model 90 GPIB commands. Table 3-4 uses the following format to list and briefly describe the complete Model 90 GPIB command set. For information on how the commands work together to perform a task, refer to paragraph 3.5. Table 3-2A is a sample from table 3-4 illustrating the columns in the command set.

Command Column

This column lists all the commands alphabetically by their full names. Arguments for the commands are indented. In the sample from table 3-4, the Model 90 recognizes the full command FREQUENCY.

Minimum Uniqueness (Min. Unin.) Column

Capital letters in this column indicate the minimum letter combination required by the Model 90. In the sample, the minimum command the Model 90 recognizes for Frequency is FR. The unit also accepts a longer abbreviation that contains all capital letters FREQ.

Command Type Column

This column lists the command types described in paragraph 3.4.2.1. Refer to paragraph 3.4.2.1 to better understand the command syntax.

Range Column

This column contains three parts: minimum value, maximum value, and enumerated value. These are the numeric arguments for the command. The enumerated value represents a numeric value that can be used in place of a minimum unique argument.

Description Column

This column describes the function of the command or argument.

Associated Key Column

This column identifies front panel keys which are related to the GPIB command. Not all commands will have an equivalent key.

Other Sources of this Data

The HELP? command provides less complete forms of the data given in table 3-4. HELP? sends a list of all the commands, arguments, and ranges to the GPIB controller.

Table 3-3. Model 90 Command Syntax

Typical Command Line: WRITE @709:"FR 2E4;OP 1;FU SQ;FR;EX"

Syntax	Explanation
WRITE @709	WRITE @709 is only an example, this command depends on the controller. This format tells the controller to send the command string out port 7 (the GPIB port) to the Model 90 (at address 09 on the GPIB bus).
"__"or '__'	Enclose the command string in quotes. Either single or double quotes can serve as string delimiters.
;	Separate commands with semicolons. See "terminators" in the text for the reasons for this requirement.

Table 3-3. Model 90 Command Syntax (Cont.)

Typical Command Line: WRITE @709:"FR 2E4;OP 1;FU SQ;FR;EX"

Syntax	Explanation
E	Use exponent notation to avoid entering long strings of zeros. For example, enter 20000 as 2E4 and 0.0005 as 5E-4.
FR	Use the minimum uniqueness version (FR), a longer version that contains the FREQ minimum uniqueness letters (FREQ), or the full version (FREQUENCY) of each FREQUENCY command in programming. Table 3-4 spells out the commands and indicates the minimum uniqueness with capital letters (FR). The text gives examples of full, partial, and minimum uniqueness command strings.
FU 2	Enumerated commands that select a function (such as FU, select channel output FU SQ waveform) allow the function to be selected by either number (3) or by name (SQ), (square waveform). Table 3-4 lists the enumerated commands and their arguments.
;FR;	Drop the numerical value of a parameter command to make the Model 90 display that parameter. For example, ;A; will display the amplitude. Use this feature in step-by-step operation to follow and verify program operation.
"EX"	Place an Execute command at the end of a command string to make the Model 90 put the commands into effect. The Model 90 will accept commands and put them in the pending setup registers, but it will not generate their output until an EX command is sent. EX also puts the Model 90 in the "listen for more commands" mode; therefore, do not put EX after a query (?) command as it will prevent the Model 90 from returning the answer.
?	Replace the numerical value of a parameter command with a ? to make the Model 90 return the current setting of that parameter as a string of characters. Table 3-4 lists the query commands and shows the format of the returning strings. Query commands also make the Model 90 display the menu of the requested parameter. The text gives a short program that makes the controller accept and display the returning information. Do not use EXECUTE after a ? command.

3.4.3 Universal and Addressed Commands

Universal and addressed (U/A) commands make most GPIB instruments perform generally accepted standard functions. Usually, universal commands control all the instruments on the GPIB bus, while addressed commands control individual instruments at specific addresses on the bus. The Model 90 accepts the following U/A commands:

Command	Type	Function
DCL	Universal	Device Clear
GET	Addressed	Group execute trigger
GTL	Addressed	Go to local
LLO	Universal	Local lockout command
SDC	Addressed	Selected device clear

Paragraph 3.4.4, Detailed Command Descriptions, discusses these U/A commands and selected Model 90 commands in detail.

Universal and Addressed Syntax

This manual uses generic names to identify the universal and addressed commands and the functions they perform. Individual controllers will use differently named commands to perform these same functions. See the manual for the controller being used to determine the actual command names and the syntax they require.

3.4.4 Detailed Command Descriptions

The following paragraphs describe in detail the unique Model 90 GPIB commands that perform functions not controlled by the front panel and the GPIB universal and addressed commands recognized by the Model 90. Use the following list to identify these specialized commands.

Command	Type	Description
DCL	Universal	Device Clear
GET	Address	Group Execute Trigger
GTL	Address	Go To Local
HELP?	Model 90	HELP?
LLO	Universal	Local Lock Out
MP?	Model 90	Main Parameters
SRQ?	Model 90	Service Request?
SQM	Model 90	Service Request Mask
SQM?	Model 90	Service Request Mask?
STB?	Model 90	Status Byte?
V?	Model 90	Version?

Front Panel Restrictions

The Model 90 limits the operator's use of the front panel with two levels of increasing restrictions as shown in table 3-5.

Table 3-4. Model 90 GPIB Command Set

Command	Min. Unin.	Command Type (3.4.2.1)	Range Min.	Range Max.	Associated Key	Description
AMPLITUDE	AM	Parameter	1E-3	15	AMPLITUDE (5)	Set Amplitude Vpp Max. 40V if HV OPT installed.
AMPLITUDE?	AM?	Query				Request current amplitude AMPLITUDE (5)
AUTO -CALIBRATE -	AC	Direct			CALIBRATE (3)	Start Auto-Calibrate
BURSTCOUNT	B	Parameter	1	1E6	BURST CNT (20)	Sets number of bursts
BURSTCOUNT?	B?	Query			BURST CNT (20)	Requests current burst count number
CALIBRATIONDUMP?		Query				
DACTEST		Parameter	0	65535		
DCOUT	DC	Parameter	-7.5	7.5	OFFSET (7)	In dc function, sets dc offset value. Max. ±20 if HV OPT installed.
DCOUT?	DC?	Query			OFFSET?	Request current dc offset value
DVMINPUT		Parameter	0	21		
DVM?		Query				
EXECUTE	EX	Direct			ENTER (35)	Executes previous commands
FASTEXECUTE	FE	Direct				Same as Execute, except faster and no error checking.
FREQUENCY	FR	Parameter	1E-3	20E6	FREQUENCY (4)	Selects Frequency Hz.
FREQUENCY?	FR?	Query			FREQUENCY (4)	Requests current frequency.
FUNCTION	FU	Parameter	0	3	FUNCTION (15)	Selects Function.
SINE	SI	Enumerated	0			Selects sine function.
TRIANGLE	T	Enumerated	1			Selects triangle function.
SQUARE	SQ	Enumerated	2			Selects square function.
DC	D	Enumerated	3			Selects dc function.
FUNCTION?	FU?	Query				Request current function.
GATEON	GN	Direct			MAN TRIG (21)	Gate mode on.
GATEOFF	GF	Direct			MAN TRIG (21)	Gate mode off.
HELP?	H?	Query				Request a list of GPIB commands.
MODE	MO	Parameter	0	7	MODE (18)	Selects operating mode.
CONTINUOUS	C	Enumerated	0			Selects continuous mode.
TRIGGER	T	Enumerated	1			Selects triggered mode.
GATE	G	Enumerated	2			Selects gated mode.
BURST	B	Enumerated	3			Selects burst mode.
AM	A	Enumerated	4			Selects AM mode.
SCM	SC	Enumerated	5			Selects SCM mode.
FM	F	Enumerated	6			Selects FM mode.
SWEEP	SW	Enumerated	7			Selects Sweep model
MODE?	MO?	Query			MODE (18)	Request current mode.
MAINPARAMTERS?	MP?	Query				Request current main parameters.
OFFSET	OF	Parameter	-7.5	+7.5	OFFSET (7)	Select waveform offset voltage (Vdc). Max. ±20 if HV OPT in-stalled.
OFFSET?	OF?	Query			OFFSET (7)	Request current offset value
OUTPUT	OP	Parameter	0	1	ON/OFF (32)	Turns output on or off.
OFF	OF	Enumerated	0			Turns output off.
ON	ON	Enumerated	1			Turns output on.
OUTPUT?	OP?	Query				Request output condition.
OUTPUTSELECT	OS	Parameter	0	4	SELECT (32)	Selects output and impedance
UNBALANCED50	U50	Enumerated	0			Selects 50Ω Unbalanced output.

Table 3-4. Model 90 GPIB Command Set (Continued)

Command	Min. Unin.	Command Type (3.4.2.1)	Range Min.	Range Max.	Associated Key	Description
UNBALANCED75	U75	Enumerated	1			Selects 75Ω Unbalanced output.
UNBALANCED600	U600	Enumerated	2			Select 600Ω Unbalanced output.
BALANCED600	B600	Enumerated	3			Selects 600Ω Balanced output.
BALANCED135	B135	Enumerated	4			Selects 135Ω Balanced output.
HIV	H	Enumerated	5			Select optional HI V output.
OUTPUTSELECT?	OS?	Query				Request current output and impedance.
PHASELOCK?	PL?	Query				Request current phase source.
PHASE	P	Enumerated	-180	+180	PHASE (12)	Selects phase shift (degrees).
PHASE?	P?	Query			PHASE (12)	Request current phase shift.
PARAMETERRESET	PR	Direct			PARAM RESET (2)	Resets last transmitted parameter
RESET	R	Direct			RESET ALL (2)	Reset all parameters except GPIB address.
RANGELOCK	RA	Parameter	0	1		Locks generator to current freq. range.
OFF	OF	Enumerated	0			Normal range.
ON	ON	Enumerated	1			Locks range.
RANGELOCK?	RA?	Query				Request current range lock condition.
RECALLSETTING	RCL	Parameter	1	10	RECALL (6)	Recalls stored settings in selected location.
RECALLSETTING?	RCL?	Query			RECALL (6)	Request last stored setting selected.
SELFTEST?	SLFT?	Query				Requests Selftest results.
STORESETTING	STS	Parameter	1	10	STORE (6)	Stores current setup in memory.
STORESETTING?	STS?	Query			STORE (6)	Request last stored setting.
SYMMETRY	SY	Parameter	5	95	SYMMETRY (11)	Selects symmetry value.
SYMMETRY?	SY?	Query			SYMMETRY (11)	Request current symmetry value.
SWEEPSTART	STA	Parameter	1E-3	20E6	SWEEP MODE (22)	Select sweepstart frequency (Hz).
SWEEPSTART?	STA?	Query			SWEEP MODE (22)	Request current sweep start frequency.
SWEEPSTOP	STO	Parameter	1E-3	20E6	SWEEP MODE (22)	Select sweepstop frequency (Hz)
SWEEPSTOP?	STO?	Query			SWEEP MODE (22)	Requests current sweep stop frequency.
SWEEPTIME	STI	Parameter	100E-3	3600	TIME (24)	Select sweeptime (seconds).
SWEEPTIME?	STI?	Query			TIME (24)	Requests current sweep time.
SWEEPTRIGFREQ	STF	Parameter	10E-3	10	TRIG FREQ (23)	Selects internal triggered sweep frequency.
SWEEPTRIGFREQ?	STF?	Query			TRIG FREQ (23)	Request current internal trigger sweep frequency.
SWEEPTYPE	STY	Parameter	0	1	LIN/LOG (22)	Selects Lin or Log sweep.
LINEAR	LI	Enumerated	0			Selects linear sweep.
LOG	LO	Enumerated	1			Selects log sweep.
ULIN	ULIN	Enumerated	2			Selects up/down linear sweep.
ULOG	ULOG	Enumerated	3			Selects up/down log sweep.
SWEEPTYPE?	STY?	Query			LIN/LOG (22)	Requests current sweep type.
SWEEPMODE	SMD	Parameter	0	4	SWEEP MODE (22)	Selects sweep modes.
START	SA	Enumerated	0		SWEEP MODE (22)	Sets generator to sweep start frequency
STOP	SO	Enumerated	1		SWEEP MODE (22)	Sets generator to sweep stop frequency.
CONTINUOUS	C	Enumerated	2		SWEEP MODE (22)	Sets generator to continuous sweep.
TRIGGERED	T	Enumerated	3		SWEEP MODE (22)	Sets generator to triggered sweep.
MANUAL	M	Enumerated	4		SWEEP MODE (22)	Sets generator to manual sweep.
SOURCE	SRC	Parameter	0	1	TRG/LOCK SOURCE (8)	Selects internal or external trigger source.
INTERNAL	I	Enumerated	0			Selects internal trigger source.
EXTERNAL	E	Enumerated	1			Selects external trigger source.
SOURCE?	SRC?	Query			TRG/LOCK SOURCE (8)	Request current trigger source.
STATUSBYTE?	STB?	Query				Requests current status byte value.
SERIALNUMBERS?SN?		Query				Requests units serial number.
TRIGGERFREQ	TF	Parameter	1E-3	20E6	TRIG FREQ (23)	Select internal trigger frequency.

Table 3-4. Model 90 GPIB Command Set (Continued)

Command	Min. Unin.	Command Type (3.4.2.1)	Range Min.	Range Max.	Associated Key	Description
TRIGGERFREQ	TF?	Query			TRIG FREQ (23)	Request current trigger frequency.
TRIGGER	TRG	Direct			MAN TRIG (21)	Initiates a trigger.
VERSION?	V?	Query				Request software version number.

GPIB Control - The Model 90 switches to GPIB control when the instrument controller asserts the GPIB REN (remote enable) line and sends to the Model 90 its listen address. The controller command string WRITE @709:"– command string –" will automatically perform these two actions. The GPIB control restricts further front panel operation as described in table 3-5. The Model 90 will remain under the GPIB control until the operator presses the LOCAL key (28).

Table 3-5. Front Panel Restrictions

	If Front Panel Operation is Limited With		
Then the Operator can:	**No Control**	**GPIB Command**	**LLO**
See the Screen Display?	Yes	Yes	Yes
Display Parameters?	Yes	Yes	Yes
Take Control Back From the GPIB?	Yes	Yes	No
Change Parameters?	Yes	No	No

Local Lockout Command - All instruments on the bus recognize the universal local lock out command LLO; it cannot be directed to just one instrument. LLO restricts operation of the Model 90 front panel as described in table 3-5.

Go To Local Command - The Go To Local command (GTL) cancels the LLO command and returns the Model 90 front panel to full operator control. All instruments on the bus recognize the addressed command GTL; however, it must be sent to each instrument individually. GTL becomes effective on receipt; the Model 90 does not require that it be followed with another command.

Group Execute Trigger Command

The Group Execute Trigger command, GET, triggers whatever trigger function set up within the Model 90. All instruments on the bus recognize the GPIB addressed GET command. However, GET can be sent to just one instrument at a time. The Model 90 triggers the selected function immediately on receipt of the GET command.

HELP? Command

The HELP? command makes the Model 90 return a list of the Model 90 primary and secondary commands and their limits as a string to the controller. HELP? requires that a program be written to make the instrument controller accept and print the returned list. The following program requests the list, accepts it, and sends it to a printer connected to the GPIB bus. Table 3-4 provides the same information as the list this program prints.

HELP Print Program

```
100   DIM A$*255              Dimension String
                              to 255 characters.
110   WRITE @709:"HELP?"      Write HELP to port
                              7, address 09.
120   READ @709:A$            Read the String
130   IF A$="0" THEN 170      If string is "0"
                              jump to 170
140   PRINT A$                Print the list
150   GO TO 120
170   END                     End Program
```

Main Parameters? Command

The MP? command makes the Model 90 return the current setting of the Model 90 main parameters as a string to the controller. The controller can save this string, then send it back to the Model 90 at a later time to restore the parameters to their previous values.

Device Clear Command

The device clear command DCL resets the Model 90 to the power-up conditions, but leaves it in the remote (GPIB controlled) mode. All instruments on the bus recognize the GPIB universal command DCL (device clear). To reset everything on the bus, use DCL @7, where 7 specifies the GPIB bus port of the controller. To reset just one instrument, use DCL @709, where 09 specifies the instrument address. The Model 90 resets itself immediately when it receives either command.

Reset Command

The RESET command resets the Model 90 to default conditions. Table 3-1 lists the Model 90 default conditions.

Version? Command

The VERSION? command makes the Model 90 return the software version of the Model 90 EPROM as a string of characters. Version? requires a program to make the instrument controller use the returned string. The following program requests the version, accepts it, and writes the data to the screen.

Version? Print Program

10	CLEAR	Clear screen
20	WRITE @709:"V?"	Write VERSION? to port 7, address 09.
30	DIM VERSION$*50	Dimension string to 50 characters.
40	READ @709:VERSION$	Read returning string
50	PRINT VERSION$	Print string to screen
60	END	End program

Running the above program will produce the following display:

WVTK 90 (VX.XX)

In this display, x gives the version number.

3.4.5 Service Requests - SRQ

The following paragraphs discusses service requests, describes the commands associated with them, and lists the service request messages the Model 90 generates. The Model 90 can set the SRQ line whenever a programming error occurs, a hardware error occurs, an event is completed, Phase lock changes state, or a Calibration message is displayed.

SRQ Concepts

What Does the Service Request Tell the Controller?

The Model 90 service request tells the controller that the Model 90 wants attention by asserting the SRQ line of the GPIB bus. Because any instrument on the bus can assert this line, the controller must read the status byte of each instrument in turn to determine which one requested attention.

What Does the Status Byte Tell the Controller?

The Model 90 uses five of the eight bits in its status byte. One tells the controller if the Model 90 requested service. The others indicate the type or types of messages (programming error, event, Phase Lock state, or Calibration messages) the Model 90 wants to send. Figure 3-6 shows the format of the Model 90 status byte. If the controller wants to know the specific message within the category, it must read the Model 90 SRQ buffer.

What Does the SRQ Buffer Tell the Controller?

The Model 90 SRQ buffer stores the programming error, event complete, Phase Lock state, and Calibration messages until the controller can read them. Tables 3-6 through 3-9 list all of the SRQ messages.

SRQ COMMANDS

The following paragraphs discuss the commands related to the service request mask, the status byte and the service request messages.

SRQ Mask Command

The SQM command makes the Model 90 selectively ignore one or more of the three types of conditions that make it produce service requests. For example, if programming errors were masked out, the Model 90 would not load messages for specific programming errors into the SRQ buffers and it would not set the PE and service request bits in the status byte. Figure 3-6 shows the positions and the corresponding decimal mask values required to block out PE, CM, PL, and EV messages. The SRQ mask is reset to SRQ mask #1 (programming error only) at power on. It is not changed by "RESET".

SRQ Mask? Command

The SQM? command makes the Model 90 return the current mask setting to the controller. The Model 90 sends the SRQ mask setting as the character string SRQMASK#, where # gives the decimal equivalent of the binary mask bits. To use SRQMASK?, write a program that first asks the Model 90 to send the mask, then tells the controller how to receive and process the returning string.

Status Byte? Command

The STB? command makes the Model 90 send its current status byte to the controller over the GPIB bus. The Model 90 sends its status byte as a string of characters with the format STB=##, where ## gives the decimal equivalent of the status byte. STatusByte? reads, but does not reset, the status byte of the Model 90. To use STatusByte?, write a program asking the Model 90 to send the status byte, then tell the controller how to receive and process the returning string.

SRQ? Command

The SRQ? command makes the Model 90 send the con-

tents of the SRQ buffer to the controller over the GPIB bus. The Model 90 sends its SRQ buffer contents as a string of characters with the format SRQ = MESSAGES, where MESSAGES represents a string of messages. Reading the SRQ buffer empties it. To use SRQ?, write a program that first asks the Model 90 to send the SRQ buffer messages, then tells the controller how to receive and process them.

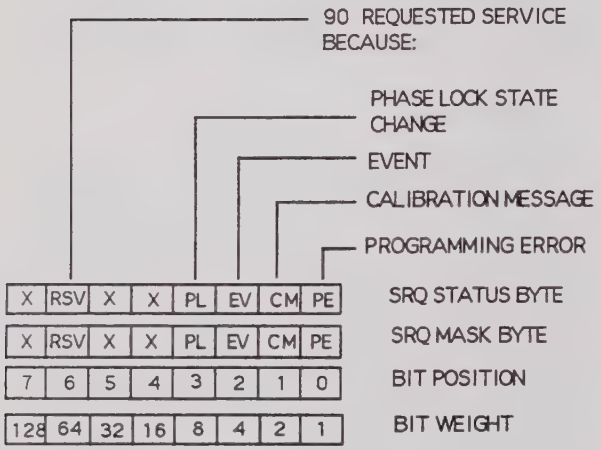

90 REQUESTED SERVICE BECAUSE:
PHASE LOCK STATE CHANGE
EVENT
CALIBRATION MESSAGE
PROGRAMMING ERROR
X RSV X X PL EV CM PE
SRQ STATUS BYTE
X RSV X X PL EV CM PE
SRQ MASK BYTE
7 6 5 4 3 2 1 0
BIT POSITION
128 64 32 16 8 4 2 1
BIT WEIGHT

Figure 3-6. Model 90 Status Byte and SRQ Mask

The Model 90 puts messages in the SRQ buffer in this general format:

SRQ=/PE:n Description//CM:n Description//EV:n Description//PL:n Description/

Slashes (/) enclose each message. PE identifies a programming error message, CM identifies the calibration error message, EV is an event complete message, and PL indicated a phase lock state change. "n" identifies a specific message within the type. This fixed format header allows a computer to easily parse (decode) the message. "Description" describes the error in English for the benefit of human readers. Table 3-6 lists all the SRQ programming error messages, table 3-7 lists all the SRQ calibration error messages, table 3-8 lists all the SRQ event error messages, and table 3-9 lists all the SRQ phase lock state change error messages.

3.4.6 Displaying Messages

The Model 90 can accept messages from the GPIB bus and display them on the front panel display. Use this feature to give instructions to an operator or to display information.

Message Format

Send messages in this format:

WRITE @709:" 'TEXT' "

The standard double quotes (") identify the command string. The single quotes (') identify the contents as a message rather than commands. Messages do not require an Execute command.

Message Size

The screen will allow a maximum message size of four lines of 16 characters. The Model 90 ignores any characters beyond these limits.

Erasing Messages

Press any key or send another GPIB command string to return to normal Model 90 displays. To erase the previous message, send a new message.

3.4.7 Selftest Query Responses

When the Model 90 receives a SELFTEST? command, it sends the total decimal value of selftest error that occurred at power on. Refer to table 3-10.

3.5 OPERATION

Paragraph 3.5 ties together the descriptions of the controls and connectors (paragraph 3.2), as well as GPIB commands (paragraph 3.4), into sets of instructions on performing various operations using the Model 90. To quickly get familiar with the Model 90, perform the Initial Checkout Procedure - paragraph 2.3.5.

The operations described in this paragraph are listed below.

Basic Instrument Setup	paragraph 3.5.3
Variable (Time) Symmetry	paragraph 3.5.4
Phase Lock and Phase Shift	paragraph 3.5.5
High Voltage Output (Option 002)	paragraph 3.5.6
Triggered Mode	paragraph 3.5.7
Gated Mode	paragraph 3.5.8
Burst Mode	paragraph 3.5.9
Amplitude Modulation	paragraph 3.5.10
Suppressed Carrier Modulation	paragraph 3.5.11
Frequency Modulation	paragraph 3.5.12
Voltage Controlled Generator VCG	paragraph 3.5.13
Continuous Sweep	paragraph 3.5.14
Triggered Sweep	paragraph 3.5.15
Manual Sweep	paragraph 3.5.16
Storing and Recalling Settings	paragraph 3.5.17

Table 3-6. SRQ Programming Error Messages

Message	Description
/PE:0 < defective command string > /	The Model 90 did not recognize the command it received. A <defective command string > is whatever erroneous data the Model 90 received over the bus.
/PE:1 < parameter header > /	This is a limit error. An attempt was made to set a parameter to an illegal value. A <parameter header> is the maximum header string; that is "FREQUENCY" or "AMPLITUDE".
/PE:2:< param# >:< param# >	This is a setting conflict error. This service request will < param name >-< param name > occur after an execute command if there are CONFLICT/ conflicting settings. It will only flag the first conflict that it finds.

< param# >	< param name >
1	FREQUENCY
2	AMPLITUDE
3	OFFSET
4	SYMMETRY
5	PHASE
6	FUNCTION
7	MODULATION
8	EXTLOCK
9	OUTPUT
10	SWP START
11	SWP STOP
12	SWP TIME
13	AMPLITUDE-OFFSET
14	RANGE LOCK

Before beginning the operation of the Model 90, review the general information in paragraphs 3.5.1 and 3.5.2.

3.5.1 Instrument Setup

Before using the Model 90, the primary power input must be connected and outputs properly terminated.

Primary Power

Before using the Model 90 verify the voltage selector and fuse (**D**) are set to match the primary power source; see paragraph 2.4.1.

Output Terminations

For proper output levels and responses, each output connector used must be properly terminated. Termination requires a correct combination of "load" or terminating impedance and the cable impedance that matches the Model 90 source impedance. Most outputs (Sweep Out,

Table 3-7. SRQ Calibration Messages

Message	Description
/CM:0 < cal index >< cal name >/	This is a failure to complete an AutoCal step. AutoCal< cal index > is a number associated with the calibration parameter that failed adjustment. < cal name > identifies a name associated with the failed calibration parameter .
/CM:1 WAIT < time > MIN/	AutoCal was attempted before the required 20 minute warm-up. < time > is the time (in minutes) remaining before an AutoCal can be performed.

Table 3-8. SRQ Event Complete Error Messages

Message	Description
/EV:0 AUTOCALIBRATION COMPLETE/	AutoCal was completed.
/EV:1 EXECUTE COMPLETE/	Execute was complete. After an execute command, the Model 90 will send either this service request or a PE:2 (assuming both PE and EV SRQ's are enabled by the SRQ mask).
/EV:2 SWEEP COMPLETE/	Sweep was completed.
/EV:3 BURST COMPLETE/	Burst count was completed.

Table 3-9. SRQ Phase Lock State Change Error Messages

Message	Description
/PL:0 PLL UNLOCKED/	The phase lock loop has changed from an unlocked state to a locked state.
/PL:0 PLL LOCKED/	The phase lock loop has changed from a locked state to an unlocked state.

Table 3-10. Selftest Query Error Messages

Message (Decimal Value)	Description
128	RAM Lost Battery Backup - Calibration Corrupted
4, 2, and 1	Main RAM Failure

Sync Out, etc.) have fixed output impedances, listed in table 3-11. The Model 90's two function outputs (Balanced and Unbalanced) have selectable source impedances; also see table 3-11. The balanced and unbalanced outputs each require different interconnection techniques. Figure 3-7 illustrates these two output interconnections.

Unbalanced Output. For the unbalanced (single ended) output, connect the output from the Model 90 to the receiving instrument using a single cable or coax and a single termination impedance; see figure 3-7 - Unbalanced Output. In figure 3-7, R_s represents the unit's selected output impedance. Proper output termination requires the cable and impedance both matches the source impedance. The receiving instrument's input impedance must be greater than the source impedance.

Balanced Output. Balanced output requires a different technique, as shown in figure 3-7 - Balanced Output. The primary use for balance outputs would be audio and telecommunication devices when driving devices with differential inputs. To connect the Model 90's Balanced Output to the receiving instrument, use a twisted pair and terminating impedance to match the selected source impedance. The example shown in figure 3-7 Balanced Output uses the receiving instrument's balanced input for termination.

Table 3-11. Model 90 Input/Output Impedances

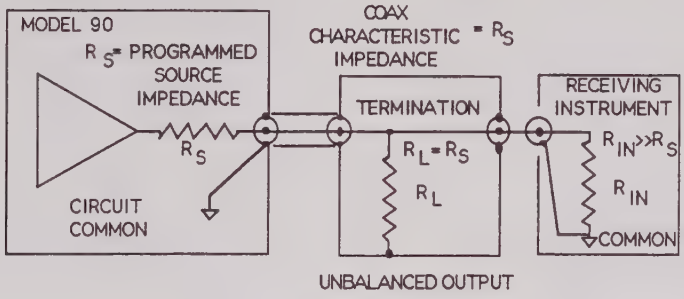
Connector	Impedance	Comments
UNBALANCED (31)	50Ω 75Ω, or 600Ω	Use SELECT (32)
BALANCED (34)	135Ω or 600Ω	Use SELECT (32)
Sweep Out (25)	600Ω	
MOD IN (26)	10 kΩ	
sync out (15)	50Ω ttl	
TRIG/LOCK IN (16)	10 kΩ	
REF IN (A)	>1kΩ	OPTION 001
ref out (B)	50Ω	option 001
High Voltage (C)	5Ω	Option 002

3.5.2 Power On and Reset

Press the POWER key (1) to turn on or off the Model 90. Turning on the power, returns the Model 90 to the last instrument setup, except the output (Balanced or Unbalanced) will be off. The last selected output impedance indicator (33) will flash. Use the ON/OFF key (32) to turn on the output.

Setting a Single Parameter to its Default Value

From the front panel use the PARAMETER RESET key (2) to reset the displayed parameter to its default value. Refer to table 3-1, key item 2, "Model 90 Default Conditions".



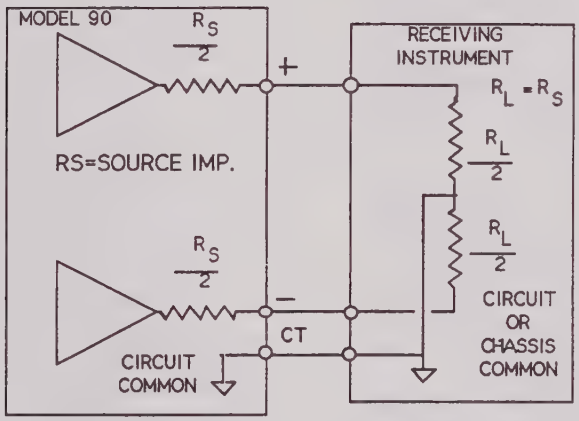


Figure 3-7. Output Terminations

Over the GPIB, send the command PARAMETERRESET or PR to reset the last transmitted value to its default value.

Setting All Parameters To Their Default Values

From the front panel, use the RESET ALL key (2) (SHIFT key and RESET ALL key) to reset all Model 90 parameters to their default values.

Over the GPIB, send the command RESET or R to reset all Model 90 parameters except the GPIB address.

3.5.3 Basic Generator Setup

The basic Model 90 produces continuous waveforms of all functions at a single frequency with a fixed amplitude. The frequency can be between 1mHz and 20 MHz. Between 20 Hz and 20 MHz the Model 90's internal synthesizer controls the frequency accuracy and stability (±10 ppm). The frequency accuracy decreases to ±3% below 20 Hz.

Paragraph 3.5.3.1 describes the steps required to set up the Model 90 for continuous outputs using the front panel. Paragraph 3.5.3.2 describes the steps required to setup the Model 90 for continuous output using a GPIB controller. Figure 3-8 shows a typical instrument setup for continuous operation.

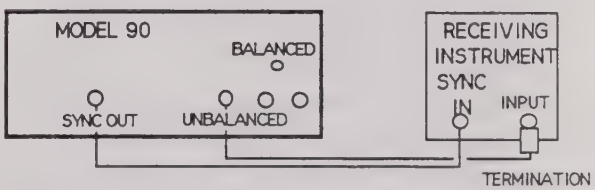


Figure 3-8. Continuous Operation Interconnection

3.5.3.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for continuous output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the continuous mode (CONT indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Function.** Use the FUNCTION key (**14**) to select the desired function: sine triangle, or square. For dc output see step 5, "DC Function". Holding down the function key causes the unit to cycle through the functions. Release the key to stop and select the function. The appropriate function indicator (**13**) will be lit.

   To step backwards through the functions, press the SHIFT key and then hold down the FUNCTION key. Release the FUNCTION key when the indicator lights to select the function.

3. **Select the Frequency.** Press the FREQUENCY key (**4**) to display the frequency. Use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the frequency. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual numbers (5000) or exponential notation (5E3), press the ENTER key to accept the new value. Frequency range for the function generator is

   1mHz to 20.00 MHz (frequency selected)

   1000.0s to 50 ns (period selected)

   Use the frequency's UNITS key (**4**) to select the unit of measure: frequency or period for the function generator (sine, triangle, and square).

   Limitations:

   Maximum frequency derates above 2MHz when symmetry not 50%

   Maximum frequency limited to 1MHz when 135Ω and 600Ω Balanced selected.

   Minimum frequency limited to 20 Hz for internal phase lock (accuracy ±10 ppm)

4. **Set up the Amplitude.** Use the AMPLITUDE key (**5**) to display the amplitude. Use the keypad (**35**) or the Knob (**37**) , if enabled (ENABLE indicator (**36**) lit), to change the amplitude. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (17)) and automatically enters the new value. When using the keypad, enter values as actual number (10) or exponential notation (1E1), press the ENTER key to accept the new value. Amplitude range is on the function selected and the amplitude units as shown below.

	Sine	Triangle	Square
Vpp	1m - 15	1m - 15	1m - 15
Vp	0.0006 - 7.5	0.0006 - 7.5	0.0006 - 7.5
Vrms	0.0004 - 5.3	0.0003 - 4.33	0.0005 - 7.5
dBm	-56 - +27.5	- 57.8 - +25.7	- 53 - +30.5

   Use the Amplitude's UNITS key (**5**) to select the unit of measure: Vpp, Vp, Vrms, or dBm.

   Limitations:

   Amplitude limited by Offset values (Offset + Vp ≤7.5V).

   Amplitude limited to half of maximum level when AM selected.

   Vpp and Vp only allowed when the dc offset is not 0Vdc, symmetry is not 50%.

5. **Set up the Offset**. Use the OFFSET key (**7**) to display the dc offset level. Offset is the waveform reference level relative to 0Vdc; see figure 3-9. Use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the offset. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (17)) and automatically enters the new value. When using the keypad, enter values as actual number (.01) or exponential notation (10E-3), press the ENTER key to accept the new value. Offset values range from +7.500V to –7.500V.

   Limitations:

   Offset limited by the peak amplitude value (Offset + Vp ≤7.5V).

   Offset fixed at 0Vdc when BAL (Balanced output)selected.

   Offset range limited to half of the maximum offset when AM selected.

DC Function. In dc function, the Model 90 produces a dc voltage. The OFFSET key, when used

with the keypad or Knob, controls the output polarity and level.

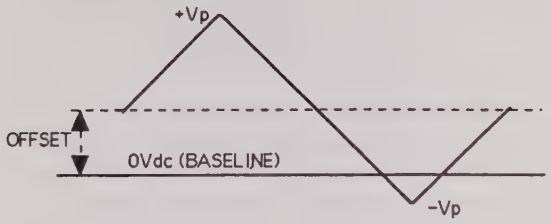


Figure 3-9. Offset Waveform Example

6. **Turn ON/OFF the Output and Select the Output Impedance.**

   Use the ON/OFF key (**32**) to turn on or off the output. If the output is turned off, it will be at power on, the impedance indicator flashes, and pressing the ON/OFF key turns on the output and returns the Model 90 to the last selected output and impedance. The impedance indicator remains on. -

   Use the SELECT key (**32**) to choose the output connector (balanced or unbalanced) and output impedance (50Ω, 75Ω, 135Ω, and 600Ω). Pressing the SHIFT key and then the SELECT key increments through the impedances and outputs in the following order:

   50Ω Unbalanced Output
   75Ω Unbalanced Output
   600Ω Unbalanced Output (frequency limited to 1MHz)
   600Ω Balanced Output (frequency limited to 1MHz)
   135Ω Balanced Output (frequency limited to 1MHz)
   High Voltage Output (Option 002 installed)

   Also after pressing the SHIFT key, hold down the SELECT key to auto-increment through the list in the same order as above. Release the key to select the impedance and output; the indicators remain lit.

   Sync Output The Sync Output pulse will be in phase with the Square wave, but will be 90° out of phase with the Sine and Triangle waves.

NOTE

When connecting the Model 90 output connector to a load, use a cable with the correct impedance for the output selected. Balanced ct connector is internally connected to the shield of all the other Model 90 BNC connectors. When connecting to external equipment, whose connector shields are at chassis ground, a ground loop will be formed that will adversely affect the Balanced output signal.

3.5.3.2 GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 for continuous output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. Select the Mode. Send the Mode command followed by the continuous parameter.

   Mode Commands: MODE or MO.

   Continuous Parameters: C or 0.

   The commands and parameters can be mixed; "MODE 0;", "MO 0;", "MODE C;", or "MO C;" will select the continuous mode.

2. **Select the Function.** Send the Function command followed by the parameter.

   Function Commands: FUNCTION or FU.

   Sine Parameters: SINE, SI, or 0

   Triangle Parameter: TRIANGLE, T, or 1

   Square Parameter: SQUARE, SQ, or 2.

   DC Parameter: DC, D, or 3

   The commands and parameters can be mixed. For example, sending either the string "FUNCTION SINE;" or "FU 0;" will select the sine function.

3. **Select the Frequency.** Send the Frequency command followed by the parameter.

Frequency Commands: FREQUENCY or FR.

Frequency Parameters: Values in Hz between 2E-3 and 20E6. Values can be entered in any format. For example 2kHz can be entered as 2000, 2E3, 20E2, etc.

For example, sending either "FREQUENCY 1E6;" or "FR 1000000;" will select 1MHz.

4. **Select the Amplitude.** Send the Amplitude command followed by the parameter.

   Amplitude Commands: AMPLITUDE or AM.

   Amplitude Parameters: Values in Vpp between 1E-3 and 15. Values can be entered in any format. For example 10 Vpp can be entered as 10, 1E1, 10E0, etc.

   For example, sending either "AMPLITUDE 12;" or "AM 1.2E1;" will select 12 Vpp amplitude.

5. **Select the Offset.** Send the Offset command followed by the parameter.

   Offset Commands: OFFSET or OF.

   Offset Parameters: Values in Vdc between –7.5 and 7.5.

   For example, sending either "OFFSET –3;" or "OF –3;" offsets the waveform by –3Vdc.

   DC Output If the dc function is selected ("FU DC;"), send the DC Output command and parameters to control the dc output voltage.

   DC Output Command: DCOUT or DC,

   DC Output Parameter (Vdc): Values can be between – 7.5 and +7.5. Values can be entered in any format. For example 2Vdc can be entered as 2 or 2E0.

6. **Turn On or Off the Output.** Send the Output enable command followed by the parameter.

   Output Commands: OUTPUT or OP.

   Parameters: 1 turns the output on, and 0 turns the output off.

   For example, sending OP 1 will turn the output on.

7. **Select an Output and Output Impedance.** Send the Output Select command followed by the parameter.

   Output Select Commands: OUTSELECT or OS.

   50Ω Unbalanced Output Parameter: U50 or 0.

   75Ω Unbalanced Output Parameter U75 or 1.

   600Ω Unbalanced Output Parameter: U600 or 2.

   600Ω Balanced Output Parameter: B600 or 3

   135Ω Balanced Output Parameter: B135 or 4.

   For example, sending either "OUTSELECT 0;" or "OS U50;" selects the unbalanced 50Ω output.

8. **Terminate the command string.** Send the EXECUTE command "EX" to terminate the command string. The Model 90 also accepts the FASTEXECUTE command (FE) which executes the command string significantly faster than the EXECUTE command. However, FASTEXECUTE only works when the frequency, amplitude, offset, or dc offset is changed, and the string is executed without any error checking.

Example

The following example uses a GPIB command string to setup the Model 90 to produce a 2kHz triangle wave, 1.5 Vpp at the unbalanced output with 50Ω impedance.

"MODE C; FU T; FR 2E3; AM 1.5; OP 1; OS U50;EX"

3.5.4 Variable (Time) Symmetry

Variable symmetry allows the duty cycle of the three standard functions (sine, triangle, and square) to be varied from 5% to 95% in 1% increments (≤2MHz). Use variable symmetry with square waves to produce pulses. Use variable symmetry with triangles to produce ramps. Between 2MHz and 20 MHz, the minimum and maximum symmetry values decrease linearly to 50% at 20 MHz; see figure 3-10. For example, at 10 MHz, the symmetry range is decreased to 25% to 75%. The symmetry of the Sync Output will track the function outputs.

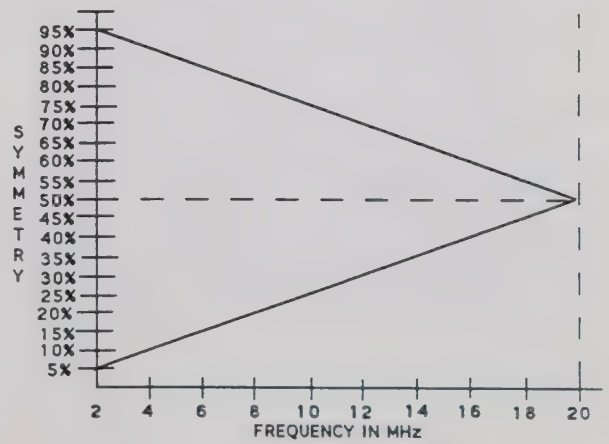


Figure 3-10. 2MHz to 20 MHz Symmetry

3.5.4.1 Local Operation

After power on (paragraph 3.5.2), set up the Model 90 as described in paragraph 3.5.3.1.

1. **Select Symmetry**. Press the SYMMETRY key (**11**) to display the current symmetry value.
2. **Change the Symmetry**. Use the keypad (**35**) or Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the symmetry. The Knob increments or decrements the value and automatically enters the new value. When using the keypad, enter the actual value. Symmetry values are 5% to 90% in 1% increments unless limited by frequency; see figure 3-10.

3.5.4.2 GPIB Operation

After power on (paragraph 3.5.2), setup the Model 90 as described in paragraph 3.5.3.2. Except add the symmetry command and parameter to the command string.

Symmetry Commands: SYMMETRY or SY

Symmetry Parameters: values in % between 5 and 95.

Send the EXECUTE command "EX" to terminate the command string.

Example

The following example uses a GPIB command string to setup the Model 90 to produce a 2kHz triangle wave at 75% duty cycle, 1.5Vpp at the unbalanced output with 50Ω impedance.

"MODE C; FU T; FR 2E3; SY 75; A 1.5; OP ON; OS U50;EX"

3.5.5 Phase Lock and Phase Shift

Phase lock allows an external or internal frequency source to control the accuracy and stability of the Model 90. Using the internal source (synthesizer) improves the Model 90 frequency accuracy to ±10 ppm. Option 001 increases the accuracy to ±1ppm. When an external source is connected, the Model 90 measures the frequency of the source, sets its frequency to match the source, and automatically phase locks itself to the source. Also, when an external source is used, the phase of the Model 90's output can be shifted relative to the source.

The Model 90 phase lock (internal and external source) limits:

Frequency – 20 Hz to 20 MHz.
Mode – Continuous, SCM, or AM.
Symmetry – 50% duty cycle only.
Amplitude (external source) – 600 mVpp to 30 Vpp

3.5.5.1 Internal Phase Lock

Local Operation.

1. **Set up the Model 90.** Set up the Model 90 as described in paragraph 3.5.3.1.
2. **Select the Internal Source.** To select the internal source (default), press the TRG/LOCK SOURCE key (**8**) to display the internal reference frequency. Each time this key is pressed, the reference source toggles between internal and external.3. **Phase Lock Indicators.** There are two front panel indicators used with phase lock: UNLOCK (**9**) and EXT (**10**).

   If the UNLOCK indicator is off, the unit is phase locked to the selected source.

   If the UNLOCK indicator is flashing, the internal source is faulty, or the external source is not connected.

   If the UNLOCK indicator is on steady, the instrument setup will not allow phase locking.

   If the EXT indicator is off, internal source is selected.

   If the EXT indicator is on, the external source is selected.

GPIB Operation

1. **Set up the Model 90.** Set up the Model 90 as described in paragraph 3.5.3.2. Except add the source command to the string.
2. **Select the Phase Lock Source.** To select the internal source, send the Source command followed by the parameter.

   Source Command : SOURCE or SRC

   Internal Source Parameter: INTERNAL, I, or 0.

   The UNLOCK and EXT indicators respond the same as in local operation

Example

The following example uses a GPIB command string to setup the Model 90 to produce a 2kHz triangle wave, 1.5Vpp at the unbalanced output with 50Ω impedance phase locked to the internal reference. "SRC I" does not need to be included because it is a default.

"MODE C; FU T; FR 2E3; SRC I; AM 1.5; OP 1; OS U50;EX"

3.5.5.2 External Phase Lock

To set up the Model 90 for external phase lock, refer to Figure 3-11.

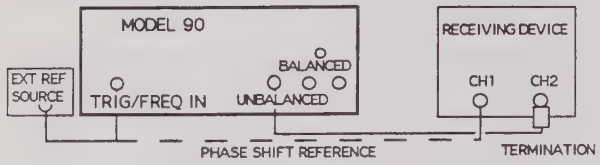


Figure 3-11. External Phase Lock Setup

Local Operation.

1. **Set up the Model 90.** Set up the Model 90 as described in paragraph 3.5.3.1.

2. **Select External Source.** To select the external source, press the TRG/LOCK SOURCE key (**8**) to display the external reference frequency (if connected) "EXTLOCK *XXXXHZ*". Each time this key is pressed, the reference source toggles between internal and external. The Model 90 measures the frequency of the external source (see external source limits), sets its generator to the measured frequency, and phase locks the generators together.

   Phase Lock Indicators. There are two front panel indicators used with phase lock: UNLOCK (**9**) and EXT (**10**).
   If the UNLOCK indicator is off, the unit is phase locked to the selected source.
   If the UNLOCK indicator is flashing, the internal reference is faulty, or the external reference is not connected.
   If the UNLOCK indicator is on steady, the instrument setup will not allow phase locking.
   If the EXT indicator is off, internal reference source is selected.
   If the EXT indicator is on, the external reference source is selected.

3. **External Source.** Connect the external source to the TRIG/LOCK IN connector (**16**). If the external source is within the limits, the Model 90 displays external frequency when EXTLOC is selected - TRG/LOCK SOURCE key (**8**). The EXT indicator also lights.

GPIB Operation

1. **Set up the Model 90.** Set up the Model 90 as described in paragraph 3.5.3.2.

2. **Select the External Source.** To select the external reference, send the Source command followed by the parameter.
   SOURCE Command: SOURCE or SRC
   Source Parameter: EXTERNAL,EX, or 1.
   The UNLOCK and EXT indicators respond the same as in local operation.

3. **External Source.** Connect the external source to the TRIG/LOCK IN connector (**16**). The EXT indicator also lights if the source is within the limits.

Example

The following example uses a GPIB command string to setup the Model 90 to produce a 2kHz triangle wave, 1.5Vpp at the unbalanced output with 50Ω impedance phase locked to a 2kHz external reference.

"MODE C; FU T; FR 2E3; SRC E; AM 1.5; OP 1; OS U50;EX"

3.5.5.3 Phase Shift

When connected to an external source, the Model 90 permits the phase of its output waveform to be shifted ±180° or ±3.14 (±p) radians relative to the external reference. See figure 3-11 for instrument setup.

Local Operation

1. **Set up the Model 90.** Set up the Model 90 for external phase lock as described in paragraph 3.5.5.2 - Local Operation. Use the signal at the TRIG/LOCK IN connector (**16**) as the phase reference.

2. **Select the Phase Shift.** Press the PHASE key (**12**) to display the current phase shift. Use the keypad (**35**) or Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the phase. Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value and automatically enters the new value. When using the keypad, enter values as actual number (120) or exponential notation (12E1), press the ENTER key to accept the new value.

3. **Selecting Alternate Units.** Model 90 allows the phase shift in degrees or radians. Press the SHIFT key and then the Phase's UNITS key (**12**) to step between degrees (°) and radians (p). After the SHIFT–UNITS key combination the Knob may be used to toggle between the units.

GPIB Operation

1. **Set up the Model 90.** Set up the Model 90 for external phase lock as described in paragraph 3.5.5.2 GPIB Operation. Use the signal at the TRIG/LOCK IN connector (16) as the phase reference.

2. **Select the Phase Shift.** Send the phase shift command followed by the parameter.

Phase Shift Commands: PHASE or P.

Phase Shift Parameters: Values in degrees between –180 and +180. Values can be entered in any format. For example 120° can be entered as 120, 1.2E2, 12E1, etc. For example, sending either "PHASE –120;" or "P –12E1;" selects –120° phase shift.

Example

The following example uses a GPIB command string to setup the Model 90 to produce a 2kHz triangle wave, 1.5Vpp at the unbalanced output with 50Ω impedance phase locked to a 2kHz external reference. Phase shift is –120°

"MODE C; FU T; FR 2E3; SRC E; P –12E1; AM 1.5; OP 1; OS U50;EX"

3.5.6 High Voltage Output

When Option 002 is installed, the Model 90 can provide 1mVpp to 40 Vpp of all functions from the rear panel High Voltage output.

3.5.6.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for the High Voltage output.

1. **Select the Mode.** Use the MODE key (**18**) to select the mode. The High Voltage output operates in all modes. To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Function.** Use the FUNCTION key (**14**) to select the desired function: sine, triangle, square or dc. The appropriate function indicator (**13**) will be lit. To step backwards through the functions, press the SHIFT key and then hold down the FUNCTION key. Release the FUNCTION key when the indicator lights to select the function.

3. **Set up the Frequency.** Use the FREQUENCY key (**4**) to display the frequency. Use the keypad (**35**) or the knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the frequency. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (1000) or exponential notation (1E3), press the ENTER key to accept the new value. Frequency range is 1mHz to 1MHz when HV OPT is selected.

4. **Set up the Amplitude.** Use the AMPLITUDE key (**5**) to display the amplitude. Use the keypad (**35**) or the knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the amplitude. The knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (10) or exponential notation (1E1), press the ENTER key to accept the new value. Amplitude range is 0.001 to 40.0 Vpp (Vpp selected),

   Use the SHIFT key and SELECT key (**32**) to step to High Voltage Out; HV OPT indicator lights (**33**). Pressing the SHIFT key, and then holding down the SELECT key auto-increments through the list . Release the key to select the output; the indicator remains lit.

5. **Set up the Offset**. Use the OFFSET key (**7**) to display the dc offset level. Offset is the waveform reference level relative to 0Vdc; see figure 3-9. Use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the offset. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (17)) and automatically enters the new value. When using the keypad, enter values as actual number (.01) or exponential notation (10E-3), press the ENTER key to accept the new value. Offset values range from +20V to –20V.
   Limitations:
   Offset limited by the peak amplitude value (Offset + Vp ≤20V).
   Offset range limited to half of the maximum offset when AM selected.

   DC Function. In dc function, the Model 90 produces a dc voltage. The OFFSET key, when used with the keypad or Knob, controls the output polarity and level.

6. **Turn ON/OFF the Output and Select the High Voltage Output.** Use the ON/OFF key (**32**) to turn on or off the output. If the output is turned off, it will be at power on, the impedance indicator flashes, and pressing the ON/OFF key turns on the output and returns the Model 90 to the last selected output and impedance.

7. **Connect The High Voltage Output.** Connect the High Voltage Output (**C**), located on the rear panel, to the receiving device. High Voltage Output source impedance is less than 5Ω and the receiving devices input impedance must be greater than 500Ω.

3.5.6.2 GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 High Voltage output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Set Up the Model 90.** Set up the Function, Frequency, and Mode as described in paragraph 3.5.3.2. Frequency range for High Voltage Output is limited to less than 1MHz.

2. **Select the High Voltage Output.** Send the Output Select command followed by the High Voltage parameter.

   Output Select Command: OUTSELECT or OS.

   High Voltage Parameter: HIV, HV, or 5.

3. **Select the Amplitude.** Send the Amplitude command followed by the parameter.

   Amplitude Commands: AMPLITUDE or AM.

   Amplitude Parameters: Values in Vpp between 1E-3 and 40. Values can be entered in any format. For example 10 Vpp can be entered as 10, 1E1, 10E0, etc.

   For example, sending either "AMPLITUDE 12;" or "AM 1.2E1;" will select 12 Vpp amplitude.

4. **Select the Offset.** Send the Offset command followed by the parameter.

   Offset Commands: OFFSET or OF.

   Offset Parameters: Values in Vdc between –20 and 20.

   For example, sending either "OFFSET –3;" or "OF –3;" offsets the waveform by –3Vdc.

   DC Output If the dc function is selected ("FU DC;"), send the DC Output command and parameters to control the dc output voltage.

   DC Output Command: DCOUT or DC,

   DC Output Parameter (Vdc): Values can be between – 20 and +20. Values can be entered in any format. For example 2Vdc can be entered as 2 or 2E0.

5. **Terminate the Command String.** Send the Execute command "EX" to terminate the command string. The Model 90 also accepts the FASTEXECUTE command (FE) which executes the command string significantly faster than the EXECUTE command. However, FASTEXECUTE only works when the frequency, amplitude, offset, or dc offset is changed, and the string is executed without any error checking.

3.5.7 Triggered Mode

In the triggered mode, the Model 90's output remains quiescent until triggered by a trigger source. All functions can be triggered. When triggered, the Model 90 produces one complete waveform and returns to the quiescent state. The Model 90 can be triggered from an external source such as a signal at the TRIG/LOCK IN connector, the front panel MAN TRIG key, or a GPIB command. In addition, the unit can be triggered using its own internal synthesizer as a trigger source. For proper operation, the trigger source frequency must be less than the output frequency.

3.5.7.1 Internal Trigger

Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered waveform output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the triggered mode (TRIG indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Internal Trigger.** Use the TRG/LOCK SOURCE key (**8**) to step to internal source (INTTRIG).

3. **Set the Trigger Frequency.** Press the TRIG FREQ key (**23**) to display the current internal frequency. Use the Knob (**37**) or the keypad (**35**) to change the trigger frequency. Use the KNOB key (**35**) to activate the Knob. The Knob automatically enters the new trigger frequency. When using the keypad, press the ENTER key to accept the new trigger frequency. Internal trigger frequency range is 1mHz to 20 MHz or 1000s to 0.0005 ms. Press SHIFT and the Trigger Frequency's UNITS key (23) to alternate between frequency (TFREQ) and period (TPER). After the SHIFT–UNITS key combination, the Knob may be used to toggle between the units.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveform is selected, refer to paragraph 3.5.4.1.

GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Select the Mode.** Send the Mode command followed by the triggered parameter.

   Mode Commands: MODE or MO

   Triggered Parameters: TRIGGER, T, or 1.

   The commands and parameters can be mixed; "MODE TRIGGER;", "MO 1;", "MODE T;", or "MO T;" will select the triggered mode.

2. **Select the Internal Trigger Source.** Send the trigger Source command and Internal parameter to select the internal trigger source.

   Source Command: SOURCE or SRC.

   Internal Source Parameter: INTERNAL, I, or 0.

   For example send "SRC 0;" to select the internal trigger source.

3. **Select the Internal Trigger Frequency.** Send the internal trigger frequency command followed by its parameter.

   Internal Trigger Frequency Command: TRIGGERFREQ or TF.

   Internal Trigger Frequency Parameters: Values in Hz between 1E-3 and 20E6.

   Values can be entered in any format. For example 2kHz can be entered as 2000, 2E3, 20E2, etc.

   For example sending either "TRIGGERFREQ 1E6;" or "TF 1000000;" will select a 1MHz internal trigger frequency.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.2.

Example

The following example uses a GPIB command string to set up the Model 90 to produce a single 2kHz, 1.5Vpp triangle waveform which is triggered by the internal 100 Hz trigger source. The output is the unbalanced 50Ω output .

"MODE T; SRC 0; TF 1E2; FU T; FR 2E3; AM 1.5; OP 1; OS U50;EX"

3.5.7.2 External Trigger

Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered waveform output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the triggered mode (TRIG indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the External Trigger.** Use the TRG/LOCK SOURCE key (**8**) to step to EXTERNAL SOURCE.

3. **Connect the External Trigger Source.** Connect the external trigger source to the TRIG/LOCK IN connector (**16**). To read the frequency of the external source, press the TRIG FREQ key (**23**). The TRIG FREQ key must be pressed each time the frequency is to be read. The EXT indicator (**10**) is lit. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, and square waveforms are selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveform is selected, refer to paragraph 3.5.4.1.

Manual Trigger Use the MAN TRIG key (**21**) to trigger the generator. When the key is pressed, the Model 90 produces one complete cycle of the selected waveform.

GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered waveform output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Select the Mode.** Send the Mode command followed by the trigger parameter.

   Mode Commands: MODE or MO

   Continuous Parameters: TRIGGER, T, or I.

The commands and parameters can be mixed; "MODE TRIGGER;", "MO 1;", "MODE T;", or "MO T;" will select the triggered mode.

2. **Select the External Trigger Source.** Send the Source command and parameter to select the external trigger source.

   Source Command: SOURCE or SRC.

   External Trigger Source Parameter: EXTERNAL, E, or 1.

   For example, send "SRC 1;" to select the external trigger source.

3. **Connect the External Trigger Source.** Connect the external trigger source to the TRIG/LOCK IN connector (16). The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, and square waveforms are selected, set up the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.2.

Example

The following example uses a GPIB command string to set up the Model 90 to produce a single 2kHz, 1.5Vpp triangle waveform which is triggered from an external source. The output is from the unbalanced output with 50Ω impedance.

"MODE T; SRC 1; FU T; FR 2E3; A 1.5; OP 1; OS U50;EX"

Triggering with GPIB Commands. To trigger the Model 90 over the GPIB, send the following command:

Trigger Command: TRIGGER or TRG.

3.5.8 Gated Mode

The gated mode is identical to the triggered mode, except the output from the Model 90 supplies continuous waveforms as long as the "trigger" is true. All waveforms can be gated. When gated, the Model 90 starts from the quiescent state, produces continuous waveforms, and returns to the quiescent state. Either the internal (synthesizer) or external trigger source gates the generator. The Model 90 externally gates using a signal at the TRIG/LOCK IN connector, the front panel MAN TRIG key, or a GPIB command. For proper operation, the trigger source frequency must be less than the output.

3.5.8.1 Internal Gate

In the internal gate mode, the Model 90 uses its internal trigger source to gate the generator. The gate on to gate off ratio while using the internal source is 1:1 (50%).

Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for gated waveform output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the gated mode (GATE indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Internal Trigger Source (Gate).** Use the TRG/LOCK SOURCE key (**8**) to step to internal gate (INTGATE) source.

3. **Set the Gate Frequency.** Use the TRIG FREQ key to display the currently selected internal frequency. Use the Knob (**37**) or the keypad (**35**) to change the trigger frequency. Use the KNOB key (**35**) to activate the Knob. The Knob automatically enter the new gate frequency. When using the keypad, press the ENTER key to accept the new gate frequency. Internal gate frequency range is 1mHz to 20 MHz or 1000s to 0.0005 ms. Press the SHIFT and then the Trigger Frequency's UNITS key (**23**) to alternate between frequency (TFREQ) and period (TPER). After the SHIFT–UNITS key combination, the Knob may be used to toggle between the units.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, and square waveforms are selected, set up the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.1.

GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 for gated output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Select the Mode.** Send the Mode command followed by the gate parameter.

   Mode Commands: MODE or MO

   Gated Parameters: GATE, G, or 2.

The commands and parameters can be mixed; "MODE GATE;", "MO 2;", "MODE G;", or "MO G;" will select the gated mode.

2. **Select the Internal Gate Source.** Send the Source command and parameter to select the internal source.

   Source Command: SOURCE or SRC.

   Internal Source Parameter: INTERNAL, I, or 0.

   For example send "SRC 0;" to select the internal source.

3. **Select the Internal Trigger Frequency.** Send the internal trigger frequency command followed by its parameter.

   Internal Trigger Frequency Command: TRIGGERFREQ or TF.

   Internal Trigger Frequency Parameters: Values in Hz between 2E-3 and 20E6.

   Values can be entered in any format. For example 2kHz can be entered as 2000, 2E3, 20E2, etc.

   For example sending either "TRIGGERFREQ 1E6;" or "TF 1000000;" will select a 1MHz internal trigger frequency.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.2.

Example

The following example uses a GPIB command string to setup the Model 90 to produce a single 2kHz, 1.5Vpp triangle waveform which is triggered by the internal trigger source at a 100 Hz rate. The output is from the unbalanced output with 50Ω impedance.

"MODE G; SRC 0; TF 1E2; FU T; FR 2E3; AM 1.5; OP 1; OS U50;EX"

3.5.8.2 External Gate

In the externally (triggered) gated mode, either an external triggering signal, a manual trigger, or a GPIB command gates the generator. The gate on to gate off time depends on the period when the trigger input signal is greater than the Model 90's trigger threshold.

Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for gated waveform output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the gated mode (GATE indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the External Gate (Trigger) Source.** Use the TRG/LOCK SOURCE key (**8**) to step to external source (EXTGATE).

3. **Connect the External Gate (Trigger) Source.** Connect the external gate source to the TRIG/LOCK IN connector (**16**). To read the frequency of the external source, press the TRIG FREQ key (**23**). The TRIG FREQ key must be pressed each time the frequency is to be read. The EXT indicator (**10**) is lit. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.1.

Manual Trigger. Use the MAN TRIG key (**21**) to gate the generator. When the key is pressed in, the Model 90 produces a continuous output until the key is released.

GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered waveform output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Select the Mode.** Send the Mode command followed by the gate parameter.

   Mode Commands: MODE or MO

   Continuous Parameters: GATE, G, or 2.

   The commands and parameters can be mixed; "MODE GATE;", "MO 2;", "MODE G;", or "MO G;" will select the triggered mode.

2. **Select the External Source.** Send the Source com-

mand and parameter to select the gate (trigger) source.

Source Command: SOURCE or SRC.

External Source Parameter: EXTERNAL, E, or 1.

For example, send "SRC 1;" to select the external trigger source.

3. **Connect the External Trigger Source.** Connect the external trigger source to the TRIG/LOCK IN connector (16). The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

4. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.2.

Example

The following example uses a GPIB command string to set up the Model 90 to produce a gated 2kHz, 1.5 Vpp triangle waveform which is triggered by an external source. The output is from the unbalanced output with 50Ω impedance.

"MODE G; SRC 1; FU T; FR 2E3; AM 1.5; OP 1; OS U50;EX"

Gating with GPIB Commands

The Model 90 generates waveforms starting with the gate on command and ending with the gate off command.

To Gate the Model 90 over the GPIB send the following commands:

Gate On Command: GATEON or GN.
Gate Off Command: GATEOFF or GF.

3.5.8 Burst Mode

The burst mode is identical to the gated mode except the Model 90 produces a user-defined number of cycles when triggered. In the burst mode, the Model 90 generates from 1 to 1,000,000 cycles. The Model 90 allows either the internal (synthesizer) or external trigger source to start the burst. External trigger sources can be the TRIG/LOCK IN connector, the MAN TRIG key, or a GPIB command.

3.5.9.1 Internal Triggered Bursts

In the internally triggered burst mode, the Model 90 uses its internal synthesizer to trigger the generator.

Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered waveform output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the burst mode (BURST indicator lit (19)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Internal Trigger.** Use the TRG/LOCK SOURCE key (**8**) to step to internal source (INTTRIG).

3. **Set the Trigger Frequency.** Use the TRIG FREQ key to display the currently selected internal frequency. Use the Knob (**37**) or the keypad (**35**) to change the trigger frequency. The Knob automatically enter the new trigger frequency. When using the keypad, press the ENTER key to accept the new trigger frequency. Internal trigger frequency range is 1mHz to 20 MHz or 1000s to 0.0005 ms. Press SHIFT and then the Trigger Frequency's UNITS key (**23**) to alternate between frequency (TFRQ) and period (TPER). After the SHIFT–UNITS key combination, the Knob may be used to toggle between the units.

4. **Enter the Burst Count.** Press the BURST CNT key (**20**) to display the currently selected burst count. Use the Knob (**37**) or keypad (35) to change the burst count. The Knob automatically enters the new value. When using the keypad, press the ENTER key to accept the new value. Burst count values range from 1 to 1,000,000 cycles.

5. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.1.

GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to setup the Model 90 for a waveform burst output. The examples shown are terminated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Select the Mode.** Send the Mode command fol-

lowed by the burst parameter.

Mode Commands: MODE or MO

Burst Parameters: BURST, B, or 3.

The commands and parameters can be mixed; "MODE BURST;", "MO 3;", "MODE B;", or "MO B;" will select the burst mode.

2. **Select the Internal Trigger Source.** Send the trigger source command and its parameter to select the internal trigger source.

   Source Command: SOURCE or SRC.

   Internal Source Parameter: INTERNAL, I, or 0.

   For example send "SRC 0;" to select the internal source.

3. **Select the Internal Trigger Frequency.** Send the internal trigger frequency command followed by its parameter.

   Internal Trigger Frequency Command: TRIGGERFREQ or TF.

   Internal Trigger Frequency Parameters: Values in Hz between 2E-3 and 20E6.

   Values can be entered in any format. For example 2kHz can be entered as 2000, 2E3, 20E2, etc.

   For example sending either "TRIGGERFREQ 1E6;" or "TF 1000000;" will select a 1MHz internal trigger frequency.

4. **Enter the Burst Count.** Send the burst count command and its parameter to enter the burst count.

   Burst Count Command: BURSTCOUNT or B.

   Burst count Parameter: 1 to 1E6.

5. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.2.

Example

The following example uses a GPIB command string to set up the Model 90 to produce a burst of ten 2kHz, 1.5Vpp triangle waveforms which are triggered by the Model 90's internal synthesizer at a 1Hz rate. The output is from the unbalanced output with 50Ω impedance.

"MODE B; B 10; SRC 0; TF 1E0; FU T; FR 2E3; AM 1.5; OP 1; OS U50;EX"

3.5.8.2 External Triggered Bursts

In the external triggered burst mode, either an external triggering signal, a manual trigger, or a GPIB command gates the generator.

Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for triggered waveform output.

1. **Select the Mode.** Use the MODE key (**18**) to step to the burst mode (BURST indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the External Trigger.** Use the TRG/LOCK SOURCE key (**8**) to step to external source EXT-TRIG).

3. **Connect the External Trigger Source.** Connect the external triggering source to the TRIG/LOCK IN connector (**16**). To read the frequency of the external source, press the TRIG FREQ key (**23**). The TRIG FREQ key must be pressed each time the frequency is to be read. The EXT indicator (**10**) is lit. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

4. **Enter the Burst Count.** Press BURST CNT key (**20**) to display the current burst count. Use the Knob (**37**) or keypad to change the burst count. The Knob automatically enters the new value. When using the keypad, press the ENTER key to accept the new value (1 to 1000000).

5. **Setup the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.1.

Manual Trigger. Use the MAN TRIG key (21) to trigger the burst. When the key is pressed in, the Model 90 begins the burst count.

GPIB Operation

After instrument setup (paragraph 3.5.1) and power on (paragraph 3.5.2), use the following steps to set up the Model 90 for burst output. The examples shown are ter-

minated with a semicolon (;) which indicates the command is part of a string. If only the one command is sent to the Model 90, replace the semicolon with EXECUTE or EX.

1. **Select the Mode.** Send the Mode command followed by the burst parameter.

   Mode Commands: MODE or MO

   Burst Parameters: BURST, B, or 3.

   The commands and parameters can be mixed; "MODE BURST;", "MO 3;", "MODE B;", or "MO B;" will select the burst mode.

2. **Select the External Trigger Source.** Send the Source command and parameter to select the external source.

   Source Command: SOURCE or SRC.

   External Source Parameter: EXTERNAL, E, or 1.

   For example, send "SRC 1;" to select the external trigger source.

3. **Connect the External Trigger Source.** Connect the external trigger source to the TRIG/LOCK IN connector (16). The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

4 **Enter the Burst Count.** Send the burst count command followed by the burst parameter.

   Burst Count Command: BURSTCOUNT or B.

   Burst count Parameter: 1 to 1E6.

5. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.2.

Example

The following example uses a GPIB command string to setup the Model 90 to produce a burst of ten 2kHz, 1.5Vpp triangle waveforms which are triggered by an external trigger source. The output is from the unbalanced output with 50Ω impedance.

"MODE B; B 10; SRC 1; FU T; FR 2E3; A M 1.5; OP 1; OS U50;EX"

Triggering with GPIB Commands. To trigger the Model 90 over the GPIB, send the following command:

Trigger Command: TRIGGER or TRG.

3.5.10 Amplitude Modulation

In Amplitude Modulation (AM), a modulating signal controls the magnitude of the Model 90's output. The Model 90 (AM selected) produces the carrier (frequency, function, and amplitude). All waveforms can be amplitude modulated. When the AM mode is selected (Local Operation), the unit shows a scale factor (x.xV= FS) which represents the peak to peak voltage required to produce full scale (100%) modulation. The scale factor displayed depends on the Amplitude value. For example, for an amplitude of 7.5Vpp, the AM scale factor will be 4V=F.S. (100%). Also the input value varies linearly which means for a 4V=F.S. scale factor a 2Vpp input signal produces 50% modulation. Exceeding 100% modulation can cause distorted outputs. In AM, the continuous Amplitude is limited to 7.5 Vpp or less. Figure 3-12 illustrates the Model 90 AM setup.

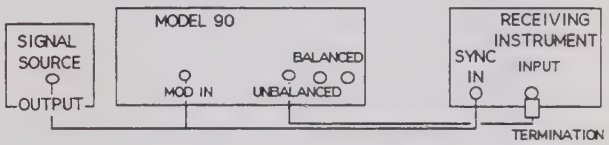


Figure 3-12. Model 90 AM and FM/VCG Setup

3.5.10.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for amplitude modulation

1. **Select the Mode.** Press the MODE key (**18**) to step to the AM mode (AM indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode. If the Amplitude is greater than 7.5V, the AM mode cannot be selected.

2. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.1. The dc function is not allowed in the AM mode.

3. **Connect the Modulating Signal.** Connect the modulating signal to the MOD IN connector (**26**). Frequency range of the modulating signal is dc to 150 kHz, and amplitude range is 0 to 4Vpp. The modulation depth is directly proportional to the modulation signal's amplitude. The AM scale factor is shown on the display when MODE: AM is selected. When the Amplitude is changed, MODE: AM must be selected again to view the new scale factor.

3.5.10.2 GPIB Operation

1. **Select the Mode.** Send the Mode command followed by the AM parameter.

   Mode Commands: MODE or MO

   AM Parameter: A or 4.

   The commands and parameters can be mixed; "MODE AM;", "MO 4;", "MODE A;", or "MO A;" will select the AM mode.

2. **Set up the Function, Frequency, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveform is selected, refer to paragraph 3.5.4.2. To select the AM mode, the amplitude must be less than 7.5Vpp.

3. **Connect the Modulating Signal.** Connect the modulating signal to the MOD IN connector (**26**). Frequency range of the modulating signal is dc to 150 kHz, and amplitude range is 0 to 4Vpp. The amount of modulation depends on the "scale factor". There is no way to view the scale factor via the GPIB. For more information on scale factor, see the AM paragraph introduction and paragraph 3.5.10.1.

Example

The following example uses a GPIB command string to setup the Model 90 for the AM mode. In this example it is assumed a 10 kHz sine wave of 4Vpp is connected to the MOD IN connector. The Model 90 is set up for 1MHz sine wave and the peak to peak amplitude at 100% modulation. The output is from the unbalanced output with 50Ω impedance.

"MODE A; FU SI; FR 1E6; AM 7.5; OP 1; OS U50;EX"

3.5.11 Suppressed Carrier Modulation

In the Suppressed Carrier Modulation mode (SCM), the Model 90 operates much the same as the AM mode, except unmodulated output level will be zero volts. In Suppressed Carrier Modulation (SCM), a modulating signal controls the magnitude of the Model 90's output. The Model 90 (SCM selected) produces the carrier (frequency, function, and amplitude). All waveforms can be modulated. When the SCM mode is selected (Local Operation), the unit shows a scale factor (2V/V) which represents Volts Output/Volts Input for required to produce an output. For example, the 2V/V scale factor means a 1V input will produce a 2V output. Figure 3-12 illustrates the Model 90 SCM setup.

3.5.11.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for suppressed carrier modulation.

1. **Set up the Function, Frequency Offset, and Output.** If sine, triangle, or square waveform is selected, set up the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, refer to paragraph 3.5.4.1. The dc function is not allowed in the SCM mode.

2. **Select the SCM Mode.** Use the MODE key (**18**) to step to the SCM mode (SCM indicator lit (**19**)). The display shows the SCM Scale Factor. To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

3. **Select the SCM Scale Factor.** When the SCM is selected, the Model 90 displays a scale factor. There are three scale factors: 2V/V, 0.2V/V, and 0.02V/V (Output Vpp/Input Vpp). Change the scale factors by using the Knob. Use the KNOB key (**35**) to activate the Knob.

4. **Null the Carrier.** During AutoCal the Model 90 calculates the carrier null values. These values will be used in the SCM mode unless the operator needs to improve the carrier null.

   To improve carrier null, connect a scope or spectrum analyzer to the Model 90. Press the AMPLITUDE key (**5**) and the display shows "SCM NULL 00". Rotate the Knob or press the keypad (35) to change the carrier null. Null can be varied between ±500 digits.

5 **Connect the Modulating Signal.** Connect the modulating signal to the MOD IN connector (**26**). Frequency range of the modulating signal is dc to 1MHz and amplitude range is 0 to 4Vpp. The magnitude of the output is directly proportional to the modulating signal's amplitude.

3.5.11.2 GPIB Operation

1. **Set up the Function, Frequency, .Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveform is selected, refer to paragraph 3.5.4.2.

2. **Select the SCM Mode.** Send the Mode command followed by the SCM parameter.

   Mode Commands: MODE or MO

SCM Parameter: SC or 5.

The commands and parameters can be mixed; "MODE SC;", "MO 5;", "MODE SC;", or "MO SC;" will select the suppressed carrier mode.

3. **Connect the Modulating Signal.** Connect the modulating signal to the MOD IN connector (**26**). Frequency range of the modulating signal is dc to 100 kHz, and amplitude range is 0 to 4Vpp. The modulation depth is directly proportional to the modulation signal's amplitude. The SCM scale factor is fixed at 2V/V when using GPIB commands.

Example

The following example uses a GPIB command string to setup the Model 90 for the SCM mode. In this example it is assumed a 10 kHz sine wave of 4Vpp is connected to the MOD IN connector. The Model 90 is set up for 1MHz sine wave and the peak to peak amplitude at full modulation will be 1.5Vpp. The output is from the unbalanced output with 50Ω impedance.

"MODE 5; FU SI; FR 1E6; AM 1.5; OP 1; OS U50;EX"

3.5.12 Frequency Modulation

In the FM mode, an external signal varies the frequency of the Model 90 about its programmed frequency. The magnitude of the modulating signal determines the maximum frequency deviation, and the frequency of the modulating signal determines the rate of deviation. Figure 3-13 illustrates Model 90 FM setup.

The following steps describe the general FM mode setup.

1. Set the Model 90 to the Continuous mode.
2. Calculate upper and lower modulation frequency limits:

   Upper Limit = Center Frequency + Peak Deviation

   Lower Limits = Center Frequency – Peak Deviation

   Where:
   Upper Limit is the upper modulation limit required.

   Lower Limit is the lower modulation limit required.

   Center Frequency is the desired center frequency (set using the FREQUENCY key (**4**).

   Peak Deviation is desired positive or negative deviation.

Example:

Desired Center Frequency = 200 kHz.
Peak Deviation = ±25 kHz.

Upper Limit = 200 kHz + 25 kH = 225 kHz
Lower Limit = 200 kHz – 25 kHz = 175 kHz

3. Using table 3-12, find and record the range number that contains the calculated upper limit.

   Also, verify that range contains the calculated lower limit.

Example:

Range number 8 contains the calculated upper limit of 225 kHz, and the range also contains the calculated lower limit.
Exceeding the Lower Limit will cause output signal distortion.

4. Calculate the modulation source amplitude (Vpp):
   Modulation Amplitude = P-P Deviation + Deviation per Volt

   Where:
   Modulation Amplitude is the amplitude (Vpp) of the modulating source.
   P-P Deviation is the total positive and negative deviation.
   Deviation per Volt (see table 3-12) is the Hz/V of the range selected in step 3.
   Example:
   P-P Deviation = 50 kHz (+ and – 25 kHz)
   Deviation per Volt from table 3-12 for range 8 = 200 kHz per Volt.
   Modulation Amplitude = 50 kHz ÷ 200 kHz/V
   = 0.25 Vpp.
5. Set the Model 90 to the upper limit frequency (step 2).
6. Set the Model 90 to the FM mode.
7. Set the Model 90 to the center frequency.
8. Connect the Modulating signal.

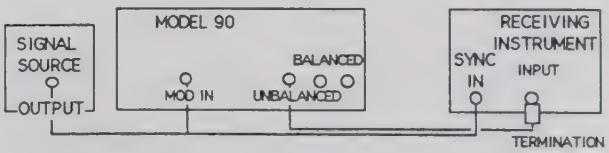


Figure 3-13. Model 90 FM Setup

3.5.12.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for frequency modulation.

1. **Select the Mode.** Use the MODE key (**18**) to step to the CONT mode (CONT indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Calculate the limits.** Use step 2 in paragraph 3.5.12. to calculate the upper and lower frequency limits.

3. **Select the Upper frequency limit.** Press the FREQUENCY key (**4**) to display the current frequency. Use the keypad (**35**) or Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to set up the upper limit frequency; see paragraph 3.5.3.1. Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value and automatically enters the new value. When using the keypad, enter values as actual number (120) or exponential notation (12E1), press the ENTER key to accept the new value.

4. **Change the Mode.** Use the MODE key (**18**) to step to the FM mode (FM indicator lit (**19**)). This "locks" the Model 90 to the fixed frequency range.

5. **Select the Center frequency.** Press the FREQUENCY key (**4**) again, and use the Knob or keypad to set up the center frequency; see paragraph 3.5.3.1.

6. **Set up the Function, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, also refer to paragraph 3.5.4.1. The dc function is not allowed in the FM mode.

7. **Calculate the Amplitude of the Modulating Signal.** Use step 4 (paragraph 3.5.12) to calculate the peak to peak voltage required to modulate the Model 90.

8. **Connect the Modulating Signal.** Set the modulating source to the level calculated in item 7, and connect the signal to the MOD IN connector (**26**). Frequency range of the modulating signal is dc to 100 kHz, and the maximum level is 10 Vpp.

3.5.12.2 GPIB Operation

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for continuous output.

1. **Calculate the limits.** Use step 2 in paragraph 3.5.12. to calculate the upper and lower frequency limits.

2. **Select the Upper frequency limit.** Send the Frequency command followed by the parameter.

   Frequency Commands: FREQUENCY or FR.

   Parameters: Values in Hz between 2E-3 and 20E6. Values can be entered in any format. For example 2kHz can be entered as 2000, 2E3, 20E2, etc.

   For example, sending either "FREQUENCY 1E6;" or "FR 1000000;" will select 1MHz.

Table 3-12. Range and Modulation Limits

Range Number	Modulation Upper Limit Range	Modulation Lower Limit	Deviation per Volt
9	2.01 to 20 MHz	20 kHz	2MHz
8	201 kHz to 2.0 MHz	2.0 kHz	200 kHz
7	20.1 to 200 kHz	200 Hz	20 kHz
6	2.01 to 20 kHz	20 Hz	2kHz
5	201 Hz to 2kHz	2Hz	200 Hz
4	20.1 to 200 Hz	200 mHz	20 Hz
3	2.01 to 20 Hz	20 mHz	2Hz
2	201 mHz to 2Hz	2mHz	200 mHz
1	20.1 to 200 mHz	2mHz	20 mHz
0	2 to 20 mHz	2mHz	2mHz

3. **Select the Mode.** Send the Mode command followed by the FM parameter.

   Mode Commands: MODE or MO

   FM Parameter: F or 6.

4. **Lock the Frequency Range.** Send the Range Lock command followed by its parameter.

   Range Lock Command: RANGELOCK or RA.

   Range Lock Parameter: ON or 1.

   NOTE: Range Lock should be turned off when finished with the FM mode: RA 0.

5. **Select the Center frequency**. Send the Frequency command followed by the parameter.

   Frequency Commands: FREQUENCY or FR.

   Parameters: Values in Hz between 2E-3 and 20E6.

6. **Set up the Function, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. If variable symmetry waveforms are selected, also refer to paragraph 3.5.4.2. The dc function is not allowed in the FM mode.

7. **Calculate the Amplitude of the Modulating Signal.** Use step 4 of paragraph 3.5.12 to calculate the peak to peak voltage required to modulate the Model 90.

8. **Connect the Modulating Signal.** Set the modulating source to the level calculated in item 7, and then connect the modulating signal to the MOD IN connector (**26**). Frequency range of the modulating signal is dc to 100 kHz and the maximum level is 10 Vpp.

Example

The following example uses a GPIB command string to setup the Model 90 for the FM mode. In this example, the output will be a 1.5Vpp sine wave from the 50Ω unbalanced output. To modulate the generator connect a 0.25 Vpp signal to the MOD IN/OUT connector.

"MODE F; FR 2E5; RA 1;FU SI; AM 1.5; OP 1; OS U50;EX"

3.5.13 Voltage Controlled Generator – VCG

VCG operation is identical to the FM mode except the Model 90's set frequency becomes the start frequency. In this mode, the voltage applied to the MOD IN connector controls the frequency of the generator. Usually the modulating signal is a dc voltage between 0 and ±10V. Maximum generator frequency change is 1000:1.

The following steps generally describe the steps to setup the VCG operation.

1. Set the Model 90 to the Continuous mode.

2. Calculate upper and lower modulation frequency limits:

   Upper Limit = Initial Frequency + Frequency Change

   Lower Limits = Initial Frequency – Frequency Change

   Where:
   Upper Limit is the upper modulation limit required.
   Lower Limit is the lower modulation limit required.
   Initial Frequency is the starting frequency (set using the FREQUENCY key (**4**).
   Frequency Change is desired positive or negative frequency change.

   Example:

   Desired Center Frequency = 200 kHz.

   Frequency Change =(+25 kHz) and (– 10 kHz)
   Upper Limit = 200 kHz + 25 kHz = 225 kHz
   Lower Limit = 200 kHz – 10 kHz = 190 kHz

3. Using table 3-12, find the range number that contains the calculated upper limit. Also, verify that range contains the calculated lower limit.
   Example:
   Range number 8 contains the calculated upper limit of 225 kHz, and the range also contains the calculated lower limit 190 kHz.
   Exceeding the Lower Limit will cause output signal distortion.

4. Calculate the level of the external dc source:

   VCG Voltage = Frequency Change ÷ Deviation per Volt
   Where:
   VCG Voltage is the external dc source voltage (±Vdc).
   Frequency Change is the positive or negative frequency change.
   Deviation per Volt (see table 3-12) is the Hz/V of the range selected in step 3.
   Example:
   Frequency Change = +25 kHz and –10 kHz
   Deviation per Volt from table 3-12 for range 8 = 200 kHz per Volt.
   VCG Voltage = +25 kHz ÷ 200 kHz/V = +0.125 Vdc
   VCG Voltage = –10 kHz ÷ 200 kHz/V =.–0.05 Vdc

5. Set the Model 90 to the upper limit frequency (step 2).
6. Set the Model 90 to the FM mode.
7. Set the Model 90 to the initial frequency
8. Connect the Modulating signal.

3.5.13.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for VCG operation.

1. **Select the Mode.** Use the MODE key (**18**) to step to the CONT mode (CONT indicator lit (**19**)).

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Calculate the limits.** Use step 2 in paragraph 3.5.13. to calculate the upper and lower frequency limits.
3. **Select the Upper frequency limit.** Press the FREQUENCY key (**4**) to display the current frequency. Use the keypad (**35**) or Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to set up the upper limit frequency; see paragraph 3.5.3.1. Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value and automatically enters the new value. When using the keypad, enter values as actual number (120) or exponential notation (12E1), press the ENTER key to accept the new value.
4. **Change the Mode.** Use the MODE key (**18**) to step to the FM mode (FM indicator lit (**19**)). This "locks" the Model 90 to the fixed frequency range.
5. **Select the Initial frequency.** Press the FREQUENCY key (**4**) again, and use the Knob or keypad to set up the initial frequency; see paragraph 3.5.3.1.
6. **Set up the Function, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the same as described in paragraph 3.5.3.1. If variable symmetry waveforms are selected, also refer to paragraph 3.5.4.1. The dc function is not allowed for VCG operation.
7. **Calculate the VCG Voltage.** Use step 4 of paragraph 3.5.13 to calculate the voltages required to change the generator's voltage.
8. **Connect the VCG Voltage.** Set the voltage source to the level calculated in step 7, and then connect the voltage to the MOD IN connector (**26**).

3.5.13.2 GPIB Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for VCG operation.

1. **Calculate the Limits.** Use the steps in paragraph 3.5.13 to calculate the upper and lower frequency limits.
2. **Select the Upper Frequency Limit.** Send the Frequency command followed by the parameter.
   Frequency Commands: FREQUENCY or FR.
   Parameters: Values in Hz between 2E-3 and 20E6.

   Values can be entered in any format. For example 2kHz can be entered as 2000, 2E3, 20E2, etc.

   For example, sending either "FREQUENCY 1E6;" or "FR 1000000;" will select 1MHz.
3. **Lock the Frequency Range.** Send the Range Lock command followed by its parameter.

   Range Lock Command: RANGELOCK or RA.

   Range Lock Parameter: ON or 1.

   NOTE: Range Lock should be turned off when finished with the FM mode: RA 0.
4. **Change the Mode.** Send the Mode command followed by the FM parameter.

   Mode Commands: MODE or MO

   FM Parameter: F or 6.
5. **Select the initial frequency.** Send the Frequency command followed by the parameter.

   Frequency Commands: FREQUENCY or FR.

   Parameters: Values in Hz between 2E-3 and 20E6.
6. **Set up the Function, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the same as described in paragraph 3.5.3.2. If variable symmetry waveform is selected, refer to paragraph 3.5.4.2. The dc function is not allowed in the VCG mode.
7. **Calculate the VCG Voltage.** Use step 4 of paragraph 3.5.13 to calculate the peak to peak voltage required to modulate the Model 90.
8. **Connect the VCG Voltage.** Set the voltage source to the level calculated in step 7, and then connect the voltage to the MOD IN connector (**26**). The maximum level is ±10 Vdc.

Example

The following example uses a GPIB command string to set up the Model 90 for the VCG operation. In this ex-

ample the output will be a 1.5Vpp sine wave from the 50Ω unbalanced output. To change the frequency, apply +0.125 Vdc to the MOD IN connector to change the frequency to 225 kHz. Apply –0.05 Vdc to change the frequency to 190 kHz.

"MODE F; FR 2E5; RA 1;FU SI; AM 1.5; OP 1; OS U50;EX"

3.5.14 Continuous Sweep

In continuous mode, the Model 90 continuously sweeps between a start and stop frequency either linearly or logarithmically. The sweep time can be varied between 0.1 and 3600 seconds. The sweep start and sweep stop frequencies can be between 1mHz and 20 MHz. If the start frequency is less than the stop frequency, the generator sweeps up in frequency. If the start frequency is greater than the stop frequency, the generator sweeps down in frequency. Maximum sweep range is three decades (1000: 1 frequency change). If the frequency range exceeds three decades, the first frequency set will be pulled to within three decades. Figure 3-14 shows the instrument setup for sweep.

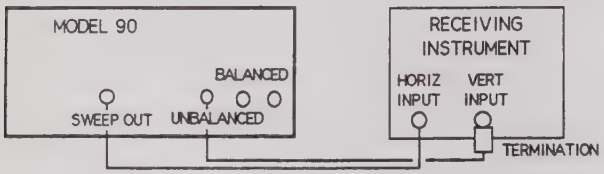


Figure 3-14. Model 90 Continuous Sweep Setup

3.5.14.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to set up the Model 90 for continuous sweep.

1. **Select the Sweep Mode.** Use the MODE key (**18**) to step to the sweep mode (SWEEP indicator (**19**) lit.

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Start Frequency.** Use the SWEEP MODE (**22**) key to step to the start frequency. When START is displayed, the current start frequency is shown. To change the start frequency, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (17)) and automatically enters the new value. When using the keypad, enter values as actual number (5000) or exponential notation (5E3), press the ENTER key to accept the new value.

3. **Select the Stop Frequency.** Use the SWEEP MODE (**22**) key to step to stop frequency. When STOP is displayed, the current stop frequency is shown. To change the stop frequency, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (5000) or exponential notation (5E3), press the ENTER key to accept the new value.

4. **Select the Sweep Rate.** Use the TIME key (**24**) to select the sweep rate. Sweep rate is the time it takes the Model 90 to sweep between the start and stop frequencies. To change the sweep time, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (90) or exponential notation (9E1), press the ENTER key to accept the new value. Sweep time values are between 100 ms and 100s. Press SHIFT and then the Time's UNITS key to shift between frequency and period. After the SHIFT–UNITS key combination, the Knob may be used to toggle between the units.

5. **Select the Sweep Type. Press the SHIFT** key (**27**) and then the LIN/LOG key (**22**) to select the sweep function. Each time the SHIFT LIN/LOG key combination is pressed or the Knob (**37**) rotated, the unit step from LINEAR SWEEP, LOG SWEEP, LINEAR SWEEP UP/DOWN, and LOG SWEEP UP/DOWN.

6. Set up the Function, **Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. The dc function can not be selected in the sweep mode. If variable symmetry waveform is selected, refer to paragraph 3.5.4.1.

7. **Select Continuous Sweep.** Press the SWEEP MODE (**22**) key until CONTINUOUS SWEEP is displayed. The unit now continuously sweeps.

8. **Connect the Model 90.** Connect the Model 90 to the receiving device. Use either the BALANCED output (**34**), the UNBALANCED output (**31**), or High Voltage Output as the sweep output. The

SWEEP OUT (**25**) provides a ramp 0 to +5V (sweep up) or +5 to 0V (sweep down).

3.5.14.2 GPIB Operation

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for continuous output.

1. **Select the Sweep Mode.** Send the Mode command followed by the sweep parameter.

   Mode Commands: MODE or MO

   Sweep Parameter: SW or 7.

2. **Select the Start Frequency.** To set up the start frequency send the start frequency command followed by the parameters.

   Start Frequency Command: SWEEPSTART or STA

   Start Frequency Parameters: Value between 1E-3 and 20E6.

3. **Select the Stop Frequency.** To set up the stop frequency send the stop frequency command followed by the parameters.

   Stop Frequency Command: SWEEPSTOP or STO

   Stop Frequency Parameters: Value between 1E-3 and 20E6.

3. **Select the Sweep Rate. Send** the sweep time (rate) command and its parameter.

   Sweep Time Commands: SWEEPTIME or STI.

   Sweep Time Parameters: 100E-3 to 36E2.

4. **Select Linear or Logarithmic Sweep.** Send the Sweep Type command and its parameter.

   Sweep Type Command: SWEEPTYPE or STY.

   Sweep type Parameter: LINEAR, LI,.or 0 for linear sweep.

   : LOG, LO, or 1 for logarithmic sweep.

   : ULIN or 2 for linear sweep up/down.

   : ULOG or 3 for log sweep up/down.

5. **Setup the Function, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. The dc function can not be selected in the sweep mode. If variable symmetry waveform is selected, refer to paragraph 3.5.4.2.

6. **Select Continuous Sweep.** Send the sweep mode command and its parameter. .

   Sweep Mode Commands: SWEEPMODE or SMD.

   Continuous sweep Parameters: C or 2.

7. **Connect the Model 90.** Connect the Model 90 to the receiving device. Use either the BALANCED output (**34**), UNBALANCED output (31), or High Voltage Output as the sweep output. The SWEEP OUT (**25**) provides a ramp 0 to +5V (sweep up) or +5 to 0V (sweep down).

Example

The following example uses a GPIB command string to set up the Model 90 for the Continuous Sweep. In this example the output will be a swept 1.5Vpp sine wave from the 50Ω unbalanced output. The output frequency varies between 1kHz and 10 kHz, and swept at a 1 second rate.

"MODE SW;STA 1E3;STO 1E4 ;STI 1; SMD 2;FU SI; AM 1.5; OP 1; OS U50;EX"

3.5.15 Triggered Sweep

In the triggered sweep mode, the Model 90, when triggered, produces one sweep beginning at the start frequency and ending at the stop frequency. In general, the setup for triggered sweep is much the same as the continuous sweep mode combined with the triggered mode. As with the triggered mode, the trigger sweep mode can be triggered by an external source, the internal trigger source, the MAN TRIG key, or GPIB commands. In the triggered sweep mode, the Model 90 limits the internally generated trigger frequency to between 0.01 to 10 Hz. Also, if the internal trigger frequency is higher than the sweep time, the Model 90 places the internal trigger frequency less than the sweep time.

3.5.15.1 Local Operation

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for continuous sweep.

1. **Select the Sweep Mode.** Use the MODE key (**18**) to step to the sweep mode (SWEEP indicator (**19**) lit. To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Start Frequency.** Use the SWEEP MODE (**22**) key to step to the start frequency. When START is displayed, the current start frequency is shown. To change the start frequency, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (17)) and automatically enters the new value. When using the keypad, enter values as actual number (5000) or exponential notation (5E3),

press the ENTER key to accept the new value.

3. **Select the Stop Frequency.** Use the SWEEP MODE (**22**) key to step to stop frequency. When STOP is displayed, the current stop frequency is shown. To change the stop frequency, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (5000) or exponential notation (5E3), press the ENTER key to accept the new value.

4. **Select the Sweep Time.** Use the TIME key (**24**) to select the sweep rate. Sweep rate is the time it takes the Model 90 to sweep between the start and stop frequencies. To change the sweep time, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (90) or exponential notation (9E1), press the ENTER key to accept the new value. Sweep time values are between 100 ms and 3600s. Press SHIFT and then the Time's UNITS key to shift between frequency and period. After the SHIFT–UNITS key combination, the Knob may be used to toggle between the units.

5. **Select the Sweep Type. Press the SHIFT** key (**27**) and then the LIN/LOG key (**22**) to select the sweep function. Each time the SHIFT LIN/LOG key combination is pressed or the Knob (**37**) rotated, the unit step from LINEAR SWEEP, LOG SWEEP, LINEAR SWEEP UP/DOWN, and LOG SWEEP UP/DOWN.

6. Set up the Function, **Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1 . The dc function can not be selected in the sweep mode. If variable symmetry waveform is selected, refer to paragraph 3.5.4.1.

7. **Select Triggered Sweep.** Use the SWEEP MODE (**22**) key until TRIGGERED SWEEP appears.

8. **Select the Internal Trigger.** Use the TRG/LOCK SOURCE key (**8**) to step to INTERNAL SOURCE.

   Set the Trigger Frequency. Use the TRIG FREQ key to display the currently selected internal frequency. Use the Knob (**37**) and the keypad (**35**) to change the trigger frequency. The Knob automatically enters the new trigger frequency. When using the keypad, press the ENTER key to accept the new trigger frequency. Internal trigger frequency range is 10 mHz to 10 Hz or 100s to 100 ms. Use the Trigger Frequency's UNITS key (**23**) to alternate between frequency and period. Press SHIFT and then the Trigger Frequency UNITS key to shift between frequency and period. After the SHIFT–UNITS key combination, the Knob may be used to toggle between the units

9. **Select the External Trigger.** Use the TRG/LOCK SOURCE key (**8**) to step to EXTERNAL SOURCE.

   Connect the External Trigger Source. Connect the external triggering source to the TRIG/LOCK IN connector (**16**). The EXT indicator (**10**) is lit. The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

   Manual Trigger Use the MAN TRIG key (**21**) to trigger the generator. When the key is pressed, the Model 90 produces one complete cycle of the selected waveform.

10. **Connect the Model 90.** Connect the Model 90 to the receiving device. Use either the BALANCED output (**34**), the UNBALANCED output (**31**), or High Voltage output as the sweep output. The SWEEP OUT (25) provides a ramp 0 to +5V (sweep up) or +5 to 0V (sweep down).

3.5.15.2 GPIB Operation

1. **Select the Sweep Mode.** Send the Mode command followed by the sweep parameter.
   Mode Commands: MODE or MO
   Sweep Parameter: SW or 7.

2. **Select the Start Frequency.** To set up the sweep start frequency, send the sweep start command followed by the parameters.

   Start Frequency Command: SWEEPSTART or STA

   Start Frequency Parameters: 1E-3 to 20E6.

3. **Select the Stop Frequency.** To set up the stop frequency, send the stop frequency command followed by the parameters.

   Stop Frequency Command: SWEEPSTOP or STO

   Stop Frequency Parameters: 1E-3 or 20E6.

4. **Select the Sweep Time.** Send the sweep time (rate)

command and its parameter.

Sweep Time Commands: SWEEPTIME or STI.

Sweep Time Parameters: 100E-3 to 36E2 in seconds.

5. **Select Linear or Logarithmic Sweep.** Send the sweep type command and its parameter..

   Sweep type Command: SWEEPTYPE or STY.

   Sweep type Parameter: LINEAR, LI,.or 0 for linear sweep.

   : LOG, L0, or 1 for logarithmic sweep.

   : ULIN or 2 for linear sweep up/down.

   : ULOG or 3 for log sweep up/down.

6. **Set up the Function, Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.2. The dc function can not be selected in the sweep mode. If variable symmetry waveform is selected, refer to paragraph 3.5.4.2.

7. **Select Triggered Sweep.** Send the sweep mode command and its parameter.

   Sweep Mode Commands: SWEEPMODE or SMD.

   Triggered sweep Parameters: Triggered, T, or 3.

Internal or External Trigger Source

8a. **Select the Internal Trigger Source.** Send the source command and its parameter to select the internal trigger source.

   Source Command: SOURCE or SRC.

   Internal Trigger Source Parameter: INTERNAL, I, or 0.

   For example send "SRC 0;" to select the internal trigger source.

   Select the Internal Sweep Trigger Frequency. Send the internal sweep trigger frequency command followed by its parameter.

   Internal Trigger Frequency Command: SWEEPTRIGFREQ or STF.

   Internal Trigger Frequency Parameters: Values in Hz between 10E-3 TO 10.

   Values can be entered in any format. For example 0.1Hz can be entered as 1E-1, or 0.1, etc.

   For example sending either "SWEEPTRIGFREQ 1E0;" or "STF 1;" will select a 1Hz internal trigger frequency.

8b. **Select the External Sweep Trigger Source.** Send the sweep trigger source command and parameter to select the external trigger source.

   Source Command: SOURCE or SRC.

   External Trigger Source Parameter: EXTERNAL, E, or 1.

   For example, send "SRC 1;" to select the external trigger source.

   Connect the External Trigger Source. Connect the external trigger source to the TRIG/LOCK IN connector (**16**). The source can be TTL (dc to 20 MHz) or bipolar (0.6 Vpp to 30 Vpp, 20 Hz to 20 MHz (default)). Minimum pulse width is 50 ns. Trigger source is hardware selectable; refer to paragraph 2.4.6. The Model 90 triggers on the positive-going edge at the zero-crossing point.

   Triggering with GPIB Commands. To trigger the Model 90 over the GPIB send the following command:

   Trigger Command: TRIGGER or TRG.

9. **Connect the Model 90.** Connect the Model 90 to the receiving device. Use either the BALANCED output (**34**) or the UNBALANCED output (**31**) as the sweep output. The SWEEP OUT (**25**) provides a ramp 0 to +5V (sweep up) or +5 to 0V (sweep down).

Example

The following example uses a GPIB command string to set up the Model 90 for the Triggered Sweep. In this example the output will be a swept 1.5Vpp sine wave from the 50Ω unbalanced output. The output frequency varies between 1kHz and 10 kHz, and swept at a 0.1 second rate. The sweep is triggered internally at a 500 mHz rate.

"MODE SW;STA 1E3;STO 1E4 ;STI 1E-1; SMD 3;SRC 0;STF 5E-1;FU SI; AM 1.5; OP 1; OS U50;EX"

3.5.16 Manual Sweep

Manual sweep allows the operator to step between the start and stop frequency using the Knob or keypad. When using the keypad, the Model 90 only allows values between the the start and stop frequencies to be entered. Also, the Model 90 displays the frequency value closest to the value entered via the keypad. Manual sweep is a local (front panel) operation.

After power on (paragraph 3.5.2), use the following steps to setup the Model 90 for continuous sweep.

1. **Select the Sweep Mode.** Use the MODE key (**18**) to step to the sweep mode (SWEEP indicator (**19**) lit.

   To step backwards through the modes, press the SHIFT key and then hold down the MODE key. Release the MODE key when the indicator lights to select the mode.

2. **Select the Start Frequency.** Use the SWEEP MODE (**22**) key to step to the start frequency. When START is displayed, the current start frequency is shown. To change the start frequency, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (17)) and automatically enters the new value. When using the keypad, enter values as actual number (5000) or exponential notation (5E3), press the ENTER key to accept the new value.

3. **Select the Stop Frequency.** Use the SWEEP MODE (**22**) key to step to stop frequency. When STOP is displayed, the current stop frequency is shown. To change the stop frequency, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit). Use the KNOB key (**35**) to activate the Knob. The Knob increments or decrements the value starting from the flashing digit (CURSOR keys (**17**)) and automatically enters the new value. When using the keypad, enter values as actual number (5000) or exponential notation (5E3), press the ENTER key to accept the new value.

4. **Select the Sweep Type. Press the SHIFT** key (**27**) and then the LIN/LOG key (**22**) to select the sweep function. Each time the SHIFT LIN/LOG key combination is pressed or the Knob (**37**) rotated, the unit step from LINEAR SWEEP, LOG SWEEP, LINEAR SWEEP UP/DOWN, and LOG SWEEP UP/DOWN.

5. Set up the Function, **Amplitude, Offset, and Output.** If sine, triangle, or square waveform is selected, set up the Model 90 the same as described in paragraph 3.5.3.1. The dc function can not be selected in the sweep mode. If variable symmetry waveform is selected, refer to paragraph 3.5.4.1.

6. **Select Manual Sweep.** Use the SWEEP MODE (**22**) key until MANSWP is displayed. The manual sweep frequency is displayed.

7. **Connect the Model 90.** Connect the Model 90 to the receiving device. Use either the BALANCED output (**34**), UNBALANCED output (**31**), or High Voltage Output as the sweep output. The SWEEP OUT (**25**) provides a ramp 0 to +5V (sweep up) or +5 to 0V (sweep down).

8. **Manual Sweep.** After Sweep Mode: Manual Sweep is selected, use the keypad (**35**) or the Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change the frequency. The Knob increments or decrements the value. When using the keypad, enter values as actual numbers (5000) or exponential notation (5E3), press the ENTER key to accept the new value.

3.5.17 Storing and Recalling Settings

All the operations described in paragraph 3.5 can be stored as a complete setup in the Model 90's memory and recalled for use when needed. Setups can be stored and recalled using both front panel keys and GPIB commands. The Model 90 allows up to 10 stored settings.

3.5.17.1 Local Operation

To Store a Setup,

1. Set up the Model 90 as described in paragraphs 3.5.3 through 3.5.16.

2. Press the STORE key (**6**) to display the number of the last stored setting. The Model 90 displays the state of the memory: FREE or USED.

3. Use the keypad (**35**) or Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change to another stored setting.

4. Press the ENTER key to store the setup at that location. When ENTER is pressed the Model 90 display flashes DONE and then USED.

To Recall a Setup,

1. Press SHIFT key (27) and then the RECALL key (**6**) display the number of the last recalled setting. If this is the first recalled setting since power on, the number will be lowest number stored.

2. Use the keypad (**35**) or Knob (**37**), if enabled (ENABLE indicator (**36**) lit), to change to another stored setting. The Model 90 displays the memory status: FREE or USED.

3. Press the ENTER key to recall the setup. Selecting a FREE location, causes the Model 90 to flash NOSAVE.

3.5.17.2 GPIB Operation

To Store a Setup,

1. Set up the Model 90 as described in paragraphs

3.5.17.2 GPIB Operation

To Store a Setup,

1. Set up the Model 90 as described in paragraphs 3.5.3 through 3.5.16.
2. Send the Store command followed by the Store parameter.

   Store Command: STORESETTING or STS.

   Store Parameter: 1 to 10.
3. Terminate the command string with an Execute command "EX".

EXAMPLE

To store a setup in setting number 2, send "STS 2; EX".

To Recall a Setup,

1. Send the Recall command followed by the Recall parameter.

   Recall Command: RECALLSETTING or RCL.

   Store Parameter: 1 to 10.
2. Terminate the command string with an Execute command "EX".

EXAMPLE

To recall a setup in stored setting number 2, send "RCL 2; EX".

MP MASTER
MA34535